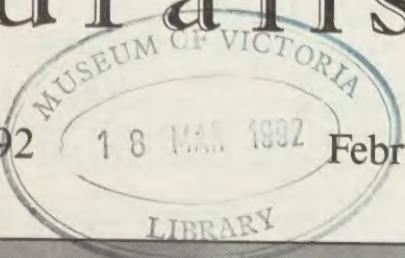


The Victorian Naturalist

Volume 109 (1) 1992

February



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FNCV Calendar of Activities

March

Sun. 1 General Group Excursion – Wattle Park Nature Ramble. Leader: Ian Faithfull. Contact Dorothy Mahler, 850 9379 or 435 8408.

Tues. 3 Fauna Survey Group Meeting – Forestry and its Effects on Wildlife: Richard Loyn. Herbarium Hall 8 p.m.

Wed. 4 Geology Group Meeting – Herbarium Hall 8 p.m. Contact Graeme Love, 282 5187 (B.H.)

Fri. 6 – Mon. 9 **Victorian Field Naturalists Clubs Association Annual Camp at The Basin.** Please note this activity will take the place of the March General Meeting and there will be no meeting on March 16 as previously advised.

Sat. 7 – Mon. 9 Fauna Survey Group Field Survey. Wilsons Promontory (post-fire ecology study). Contact Anne Casey, 380 8290.

Thurs. 12 Botany Group Meeting – Hawaii: Malcolm Calder. Herbarium Hall 8 p.m.

Sat. 14 Fauna Survey Group Field Survey. Leadbeaters Possum Survey. Contact Ray Gibson, 874 4408.

Wed. 18 Microscopy Group Meeting – Plant Sections: an explanation of what we see. Astronomer's Residence 8 p.m.

Sat. 28 Fauna Survey Group Field Survey. Leadbeaters Possum Survey. Contact Ray Gibson, 874 4408.

Sat. 28 Botany Group Excursion – Native Berries at Upper Thomson River. Contact Joan Harry, 850 1347.

April

Wed. 1 Geology Group Meeting. Herbarium Hall 8 p.m. Contact Graeme Love, 282 5187 (B.H.).

Sun. 5 General Group Excursion – Geology and Shell Studies at Black Rock Coastal Area. Leader: Dan McInnes. Contact Dorothy Mahler, 850 9379 or 435 8408.

Tues. 7 Fauna Survey Group Meeting – Insect/Plant Interactions: John Reid. Herbarium Hall 8 p.m.

Thurs. 9 Botany Group Meeting – Kangaroo Island: Hilary Weatherhead and Ilma Dunn. Herbarium Hall 8 p.m.

Sat. 11 Fauna Survey Group Field Survey. Leadbeaters Possum Survey. Contact Ray Gibson, 874 4408.

Mon. 13 General Meeting – **Annual General Meeting.** Herbarium Hall 8 p.m.

Wed. 15 Microscopy Group Meeting – Simple Methods of making Opaque Mounts for insects, forams or botanical specimens. Astronomer's Residence 8 p.m.

Fri. 17 – Fauna Survey Group Field Survey. Jilpanger Scrub Survey. Contact Tues. 21 Laurie Conole, 481 4926.

Sat. 25 Botany Group Excursion – 'Seawinds', bone seed pulling and Greens Bush. Contact Joan Harry, 850 1347.

The Victorian Naturalist



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Editor: Robyn Watson
Assistant Editors: Ed and Pat Grey

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*Cover photo: Large Duck Orchid, *Caleana major*, see the article on the orchids of French Island, p.16*

Notice of the Annual General Meeting

The Annual General Meeting of the Field Naturalists Club of Victoria will be held at the **National Herbarium**, Birdwood Avenue, South Yarra at **8 p.m. on Monday, April 13, 1992**.

Agenda

1. Confirmation of the minutes of the previous Annual General Meeting held on 13 May 1991.
2. Receipt and adoption of Annual Report for the year ended 31 December 1991.
3. Receipt and adoption of Financial Statements and associated reports.
4. Election of Members of Council.
5. Election of Office Bearers.
6. Appointment of Auditors (remuneration to be determined by Council).
7. Any other business of which proper notice has been given in accordance with the Articles of Association.
8. President's Address – "Kakadu plus other interests".

Election of Councillors and Office Bearers

All members of Council and Office Bearers retire annually but are eligible for re-election. Nominations by two financial members of the Club are required for the following positions:

Council

President
Vice-President
Ten other members

Office Bearers

Secretary
Treasurer
Editor
Activities Co-ordinator
Librarian
Subscriptions Secretary
Excursion Secretary
Conservation Co-ordinator
Publicity Officer
Sales Officer (Books)
Sales Officer (Victorian Naturalist)

This is your Club, and all members are urged to ensure its on-going viability by filling all the above positions with persons willing and able to contribute to activities and functions. Arrange a nomination for yourself or encourage some other appropriate member to be nominated.

Nominations should be in the hands of the Secretary before the Annual General Meeting.

Book Review

Australian Waterbirds – A field guide

by Richard Kingsford

Publishers: *Kangaroo Press Pty. Ltd. (1991).*
90 colour plates, 128 pages, r.r.p. \$14.95 (soft cover).

This is a well produced guide to 90 species of Australian fresh-water birds. It concentrates on birds associated with inland waters and does not pretend to cover all species associated with fresh-water environments. For example the Reed Warbler and Swamp Harrier are omitted.

Very good photographs are used to illustrate each bird in a natural setting. While no note is made of the sex shown, it is presumably male as the text details female differences. Keys around the

photographs show the depth of water associated with each species as well as the food eaten. Silhouettes are used to good effect for both broad identification and each individual species. Size is shown by comparison with a human hand or body. The information is shown in a very visual way and thus easily picked out.

This small field guide is visually attractive and would provide the naturalist, beginning a study of water birds, with an easy-to-use introduction.

Ed. Grey

Library Reopening

The good news for 1992 is that the Club's library has moved into new premises, and is now operating again. It is located in a small building behind the Astronomer's Residence (next door to Governor La Trobe's Cottage). The library will be open, initially, before the monthly General Meeting, from 7.15–7.55 p.m. It is hoped that it will be open for Group Meetings in the near future, and also at times during the day, depending on demand and the availability of people to be on duty.

If you are interested in helping with the library in any way I would be pleased to hear from you. You may phone the FNCV office on (03) 650 8661 or contact me direct on (054) 28 4097.

During the long period that the library has been in store we have continued to receive numerous periodicals, which are now available to members. The acquisi-

tion of books has been necessarily curtailed, but did not entirely cease. The following are titles which have been added to stock recently.

Buchanan, R. A. (1989). 'Bush Regeneration'. (NSW TAFE Student Learning Publications.)

'Green Pages 1991-92'. Directory of Environment Groups. (ACF: 1991.)

Lines, W. J. (1991). 'Taming the Great South Land'. (Allen & Unwin.)

Moulds, M. S. (1990). 'Australian Cicadas'. (NSWUP.)

Books and periodicals may be borrowed for two months. If you wish to keep books for another two months it would greatly assist the library staff if you would renew your loan.

Sheila Houghton
Hon. Librarian

Do they predate or not?

Encouraged by your editorial in the February 1990 issue seeking a consistent style for the journal, I wish to lodge a strong protest and warning about the invidious misuse of the verb "to predate" and its participle "predating".

As every well-read naturalist knows, predate is most often used in archaeology and has the sense of antecedence... "recently discovered artifacts demonstrate that the presence of the *Orror* tribe predates that of the *Watson* clan..." Similar legitimate uses are to be found in the literature of palaeontology and some other branches of geology.

How, then, can ecologists and others of that ilk speak of animals predating upon other creatures? Do they mean that some of the animals arrived earlier, but there has been a nasty mix-up of preposition in the sentence? Unfortunately the answer is that they have wrongly derived their new word from "predacious" or "predatory". Predators prey upon their quarry; they do not predate upon it. Enough of this nonsense; let us hear the expression no more!!

The ultimate fantasy comes in the statement that phytophagous insects predate on leaves and flower buds. (This is a true example slightly altered to disguise the author.) Herbivores graze ... in a biological context predatory implies carnivory.

If ecologists want to use the word "predate", let them do it only in terms of succession. Let us remind them that carnivores prey upon other animals and that plant-eaters have no cause to become raptorial. I am bolstered in my argument by the Shorter Oxford Dictionary whose authors have got the definitions right for all of these terms.

Ian Endersby
Montmorency

Weeds along the Two Bays

walking track,
Arthurs Seat

This year, with an excellent voluntary co-ordinator in Stuart Weir (059 863 1644), the flora and fauna-threatening weeds are once again being systematically tackled on the Arthurs Seat State Park. The main weeds are the large bushes of Boneseed (South African *Chrysanthemoides monilifera*), Sollya (*Sollya heterophylla*) from Western Australia and the Gippsland *Pittosporum undulatum*.

The wildflowers of the Arthurs Seat (Dromana) section of the Two Bays track and surrounds should increase as the present, and hopefully more, voluntary groups return each April to check and hand-pull the young seedling weed regrowth.

Other means of eradication are still at the experimental stage. They are expensive and impossible to implement due to lack of Department of Conservation and Environment staff numbers.

Stuart Weir and the Park rangers wish to thank all the groups who participated in 1991. These included several Walking Clubs, Conservation and Community Services and other groups from Melbourne and the Peninsula.

They look forward to other volunteer groups joining, particularly younger and senior school groups, when work for a weed-free Arthurs Seat State Park recommences in March-April 1992 after rains.

Please contact Stuart if you would like to participate.

Stefanie Rennick
East Bentleigh

The Foraminiferal Fauna of Mallacoota Inlet, East Gippsland, Victoria.

K. N. Bell* and S. R. Drury**

Introduction

Along the coastline of East Gippsland there are several estuaries – Sydenham, Tamboon, Wingan and Mallacoota Inlets.

These inlets formed by the drowning of the seaward valleys of river systems during the increase in sea level which reached its maximum about 6000 years before the present, i.e. they are of mid-Holocene age (Bird 1973). Later, offshore barrier islands and sand spits extended across the mouth of the various inlets restricting the marine influence to a greater or lesser extent. Marine shells from 400–450 mm and 700–900 mm below the surface at Howe's Flat, east of Mallacoota, have been C-14 dated at 3500 yr B.P. and 3780 yr B.P. respectively (Gill 1971).

This report deals with the foraminiferal fauna found living in Mallacoota Inlet, the largest of these bar-built estuaries.

Mallacoota Inlet is situated at the mouth of the Genoa River (Fig.1). It is bounded seawards by an extensive beach and dune complex which allows only very restricted water exchange with the Tasman Sea. The Inlet can be divided into two main basins – Top Lake and Bottom Lake, with the latter being further divided by the shallow and extensive Goodwin Sands, which are exposed at low tide, into two separate parts, the Northern and Southern Basins. Top and Bottom Lakes are joined by a narrow but deep strait known locally as the 'Narrows'.

Because the Inlet is surrounded by National Park (except for the three small farming areas) and only two small villages, Genoa and Mallacoota, occur within the catchment of the systems there is little, if any, pollution of the waters.

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** 22 Trease St., Leongatha, Victoria, 3956.

Previous work on the marine fauna has been seemingly restricted to miscellaneous collections over many years with no definite surveys carried out.

Reinson (1977) has studied the hydrology and sedimentation within the Inlet, and the following summary of the environment is based upon his work.

The tidal range in the Inlet is small, varying from about 0.7 m near the entrance to almost negligible in the central and upper reaches. The water depth varies greatly; the shallowest parts are the seaward end and about the Goodwin Sands; the Northern and Southern Basins are between 1.5 and 6 m deep as is Top Lake. The 'Narrows' is a deep, narrow channel with an irregular bottom profile and ranges from 6 to more than 10 m deep, as is the river channel upstream from Top Lake, where the deepest water is to be found (Cape Horn, 28 m).

The salinities of the waters depend upon the interplay between the inflowing freshwater and the marine tidal flow. Under normal conditions the salinity is more or less well stratified, with the freshwater forming a surface lens extending into the South Basin to about the Goodwin Sands; along the bottom of the Inlet the saltier marine waters form a wedge and extend up and into Top Lake. At intermediate depths there are more or less regular salinity changes due to the mixing of the two water masses, so giving rise to a stratification of salinity levels. Except in the extreme northern section of Top Lake the bottom water in normal times is of a salinity greater than about 26 ppt (normal seawater 35 parts per thousand). During times of great freshwater input the saltwater wedge is limited in its northern extent and Top Lake may become totally fresh. Due to the irregular

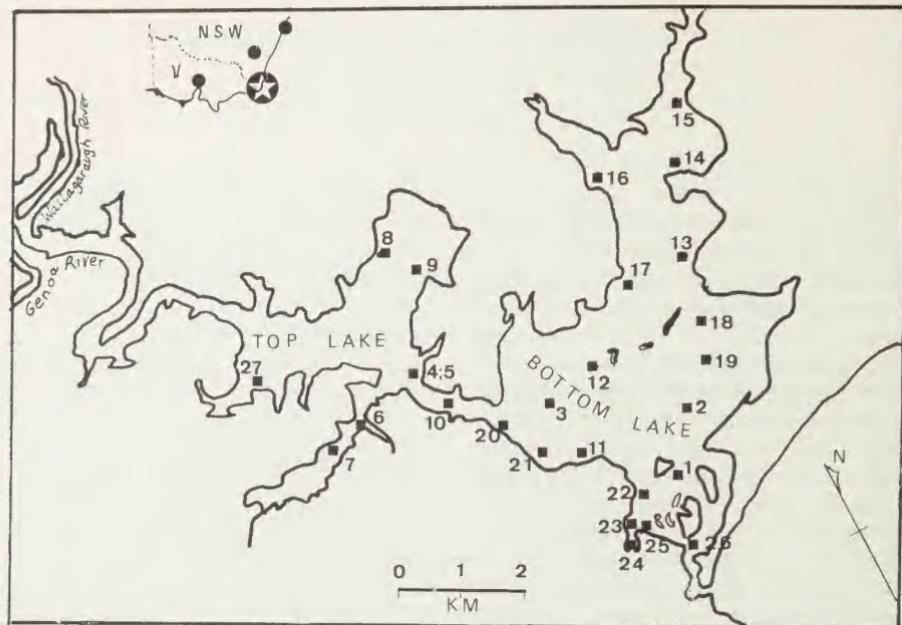


Fig. 1. Mallacoota Inlet, showing sample sites.

bottom topography, and the circulation pattern of the water within the Inlet, saltwater can remain undisturbed in the deeper parts of the 'Narrows' and Southern Basin for several months.

Water temperatures are also stratified in line with the salinity. Reinson (1977) does not give actual bottom temperatures (of most concern with studies on foraminifers) but from his figures the Southern Basin bottom temperature is slightly less than 18°C and Top Lake less than 16°C in summer, with winter temperatures about 4°C lower.

The sediment distribution in the Inlet is related to the water circulation pattern – sandy sediments (southern seaward end and at the freshwater/marine interface in Top Lake) are found where the water currents are greatest, and muddy sediments in the basins and river channel as the currents are weak at depth. As the deeper water circulation is restricted in the Inlet due to the bottom topography, the bottom waters are stagnant and partly

anoxic, and the surface sediments are characterized by high organic matter content, hydrogen sulphide odour and a blackish colour.

Methods

Samples were collected using a small hand-operated grab which collected about one litre of sediment, on 30 April and 1–3 May 1987. This was immediately mixed with 70% alcohol as a preservative. The samples studied vary from a black, smelly mud (samples 3–10, 12, 13, 16, 17, 20, 21), a sandy mud (samples 2, 11, 19, 27), gravelly mud (samples 14, 15) to a sand and gravelly mud (samples 1, 18, 22–26). For study a sample (10 g) of the sediment from each site was washed several times to remove the larger fragments (gravel, weed, molluscs) and fine silt, and then placed in rose Bengal solution for four hours; this stains the protoplasm and so indicates live collected specimens. The samples were then re-washed, air-dried and the residue concentrated using carbon tetrachloride.

In samples in which live foraminifera were uncommon, further 10 g sub-samples were processed until about 300 specimens were recovered.

Living foraminiferal fauna

The living foraminiferal fauna consisted of 34 species placed in 21 genera; Textulariidae (agglutinate forms) comprised 16 spp (10 genera), Milioliidae (calcareous imperforate forms) 5 spp (4 genera) and the Rotaliidae (perforate calcareous forms) 13 spp (7 genera). The relative percentage abundance of these three main groups of foraminifera in each sample has been plotted in Fig. 2. Inspection shows that Bottom Lake samples can be divided into two suites - North Basin with high textulariid and very low milioliid and rotaliid values, and South Basin with low textulariid and variable milioliid and rotaliid values, these are the characteristics of a hypo-saline lagoon and a normal marine lagoon respectively (Murray 1973).

Living specimens were infrequent to rare, averaging about 30 living specimens/10 g of sediment; this contrasts with the northern section of Western Port with 300-500/10 g and Swan Bay 100/10 g (Bell unpublished data). This is most likely

due to the partly anoxic nature of the sediments.

Table 1 shows the number of species restricted to or common to the three sedimentary basins at Mallacoota Inlet. Top Lake has 5 spp (all agglutinate) restricted to its waters out of a fauna of 13 spp; Northern Basin, one calcareous species out of a fauna of 7 spp; and Southern Basin 18 spp restricted out of 28 spp.

Table 1. Number of species restricted to, or common to, the various sedimentary basins at Mallacoota Inlet.

	Restricted to		Common to		
	Top Lake	Bottom Lake			
			N	S	T/S
Agglutinate	5		7		1 3
Calcareous		1 11	4	1	1
Total	5	1	18	4	2 4

Two simple statistical calculations, on the diversity coefficient between the samples and on the constancy of the species, can enable us to find whether there is a zonation of fauna within the Inlet and, if so, which species are characteristic of those zones.

(a) Diversity Coefficient

Comparisons and relationships between various samples can be made quantitatively using the Jaccard coefficient of association. This is a measure of the similarity between any two samples and is calculated from $A = C/N_1 + N_2 - C$ where C is the number of species in common between the two samples being compared, and N_1 and N_2 are the number of species in each of the two samples. The two samples with the greatest association coefficient are combined and the similarity values again calculated for all pairs of samples. Proceeding thus until all the samples are combined, a cluster diagram or dendrogram can be formed showing the degree of closeness between

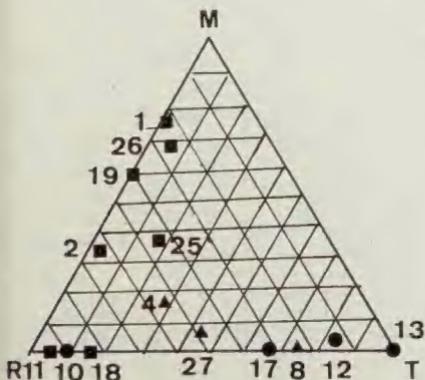


Fig. 2. Relative percentage abundance plot of the Milioliid: Rotaliid: Textulariid values.
Key to symbols: \square - North Basin, \square - South Basin, \triangle - Top Lake.

the various samples (Fig. 3). This shows that for Mallacoota Inlet there are two main associations – Group A comprising samples from Top Lake, Northern Basin and the edge of the Goodwin Sands, and Group B – those samples from the Southern Basin of Bottom Lake. (Samples 10, 21 and 22 were omitted because very few live specimens could be found, and other samples not shown in the dendrogram had no live foraminifers.)

(b) *Species constancy*

The two groups of sample sites can be distinguished by their faunas. We can do this by using the constancy (or presence of species) coefficient $C = 100p/N$ where p is the number of samples containing the species concerned, and N is the total number of samples in each of Groups A and B. According to this coefficient there are three specific categories of the value of C (Sanchez Ariza 1983):

- constant species, present in more than 50% of the samples;
- accessory species, present in 25–50% of the samples;
- accidental species, present in less than 25% of the samples.

The calculated values for each of the species for either Group A or B are given in Table 2. These figures show that two species *Eggerella subconica* and *Ammonia aoteanus* are widespread throughout the Inlet. Also we see that Group A can be characterized by the species *Miliammina fusca*, *Reophax barwonensis* and *Elphidium depressulum* with accessory species *Ammobaculites barwonensis* and *A. exiguis*, and that Group B is characterized by *Quinqueloculina seminula*, *Q. poeyana*, *E. advenum*, *Brizalina pseudoplicata* and *B. compacta* with accessory species *R. nana*, *Haplophragmoides pusillus*, *Textularia porrecta*, *E. gunteri corioensis* and *Cyclogyra planorbis*.

Dead foraminiferal fauna

A large and diverse dead fauna was found in the southern part of Bottom Lake between Stingray Point and Teatree Point. This dead fauna comprises over 100 species, including some pelagic species, all of which are characteristic of open marine well-oxygenated waters. The samples from this area (1, 2, 22, 25, 26) had a small live fauna of 27 spp (of which only 7 were common, the remainder rare or single

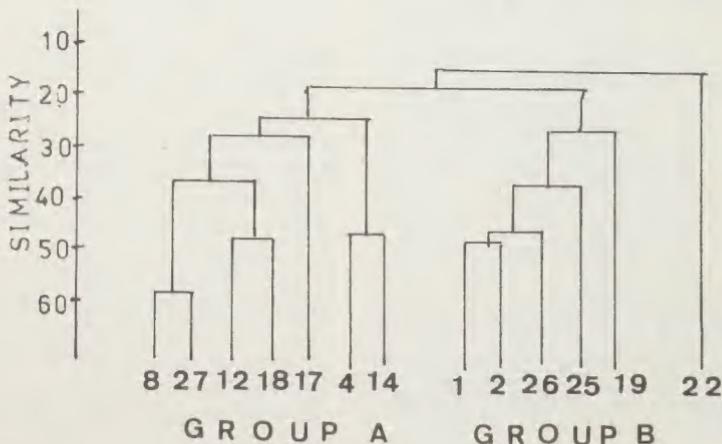


Fig. 3. Cluster dendrogram showing the similarity coefficients between samples. Unlisted samples had too few specimens to use.

Research Report

Table 2. Foraminiferal species distribution and species constancy values.
(Samples 3, 5, 6, 7, 9, 11, 13, 15, 16, 23, 24 contained no live foraminifers.)

Species/Sample	1	2	4	8	10	12	14	17	18	19	20	21	22	25	26	27	Group A	Group B	
<i>Hippocrepina</i> sp.						x							x				16	11	
<i>Miliammina fusca</i>				x	x		x	x								x	70	0	
<i>Ammodiscus mestayeri</i>			x														14	0	
<i>Egerella subconica</i>		x	x	x	x	x	x			x			x	x	x	84	50		
<i>E. polita</i>	x				x		x	x						x			40	25	
<i>Leptohalysis</i> sp.													x	x			0	12	
<i>Reophax barwonensis</i>	x	x	x		x		x						x	x	x	70	40		
<i>R. nana</i>				x									x				0	25	
<i>Haplophragmoides pusillus</i>													x	x	x		0	25	
<i>Ammobaculites barwonensis</i>				x					x							x	30	12	
<i>A. exiguum</i>			x													x	30	0	
<i>Ammoscalaria</i> sp.													x			x	0	12	
<i>Textularia porrecta</i>										x		x	x				0	38	
<i>Trochammina sorosa</i>												x				x	0	12	
<i>T. inflata</i>										x						x	14	12	
<i>Martinoteilla</i> sp.			x														14	0	
<i>Quinqueloculina poeyana</i>	x	x			x			x					x	x			14	62	
<i>Q. seminula</i>	x	x	x						x		x	x	x	x	x		28	75	
<i>Spiroloculina aequa</i>												x				x	0	12	
<i>M. australis</i>												x				x	0	12	
<i>C. planorbis</i>	x											x				x	0	25	
<i>Bulimina gibba</i>	x											x	x			x	0	40	
<i>Brizalina pseudoplicata</i>	x	x	x						x			x				x	14	50	
<i>B. compacta</i>	x	x										x	x			x	0	50	
<i>Rosalina australis</i>												x				x	0	12	
<i>Ammonia aoteanus</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	100	100		
<i>Elphidium advenum</i>	x	x					x					x	x			x	14	50	
<i>E. depressulum</i>		x	x	x		x			x		x		x	x	x		56	40	
<i>E. crispum</i>												x				x	0	12	
<i>E. argenteum</i>						x										x	14	0	
<i>E. gunteri corioense</i>	x											x				x	0	25	
<i>E. simplex</i>				x	x		x		x			x	x	x	x		42	40	
<i>E. poeyanum</i>	x				x					x		x				x	14	40	
<i>Nonionella auris</i>												x				x	0	12	
No. spp/sample	8	11	6	9	3	9	4	7	4	4	6	3	4	25	12	10			

specimens only) characteristic of slightly lower salinity waters. This large dead fauna is indicative of a time when the entrance was much more extensive and water flow greater than the present. This dead fauna has not yet been studied fully.

Notes on selected species

No full documentation or description of the various species is given here as most are well known brackish or normal marine shallow-water foraminifers. However some species are first records for Victorian waters or are worth some minor remarks on their identification. Many of the species mentioned can be found figured in Albani (1979).

Agglutinate species:

Hippocrepina sp. cf. *flexibilis* Wiesner (1931).

Small, very finely arenaceous sac-like tests are placed here. Identification at species level is not certain as only four specimens were covered and each showed some form of test distortion. *Hippocrepina flexibilis* was recorded from sub-antarctic waters by Parr (1950) and similar specimens have been found in Western Port and in Queensland waters (pers. obs.).

Milliammina fusca Brady (1879) (Fig. 4.1).

This is a characteristic species of all Victorian hypo-saline waters. All specimens from Mallacoota Inlet were small and incorporated much black material in their tests which gave them a very dark appearance. All specimens had an apertural tooth.

Ammodiscus mestayeri Cushman (1919) (Fig 4.2).

Parr (1945) recorded this species from shore sands at Barwon Heads. Both megalospheric and microspheric generations are present at Mallacoota.

Eggerella subconica Parr (1950) (Fig 4.3).

Parr described this species from Tasmanian waters and referred to it a specimen collected (dead) from Barwon

Heads (Parr 1945). The Tasmanian specimens had four chambers in the last whorl whereas the Barwon Heads specimen only three. All the Mallacoota specimens had three chambers in the last whorl.

Eggerella polita Collins (1953) (Fig. 4.4).

Originally described from the Great Barrier Reef; this seems to be the first record for Victorian waters.

Leptohalysis sp.

This delicate, flexible species is to be described in a forthcoming paper on the foraminiferal fauna of Western Port. It has been found living in Western Port and in Port Phillip Bay (Collins 1974) and also as a fossil in an as yet undescribed core from Corner Inlet. It is related to the *scotti* group of campanulate-chambered flexible species formerly placed in *Reophax* but transferred to *Leptohalysis* by Loeblich and Tappan (1984).

Reophax barwonensis Collins (1974) (Fig. 4.5).

A widespread species in the Inlet but only rare specimens were found in Group B samples. The size of the proloculus varies – a few specimens show one as large as that figured by Collins but usually it is not larger than the succeeding chamber. Loeblich and Tappan (1984) placed this species in their new genus *Scherochorella*; however, it is here retained in *Reophax* as it differs in many respects from *Scherochorella* viz. large not tiny, aperture not flush, test not flattened, test wall not thin.

Reophax nana Rhumbler (1913).

In samples 10 and 25 rare specimens of a small, linear *Reophax* occur which seem to be identical with that figured by Parker *et al.* (1953) from San Antonio Bay, Texas, as *R. nana*. Previous records are all from deep ocean waters and it may be that the Mallacoota Inlet specimens belong to a new species.

Haplophragmoides pusillus Collins (1974) (Fig 4.6).

Originally described from Port Phillip Bay this species has not been subsequently recorded.

Ammobaculites barwonensis Collins (1974) (Figs 4.7-4.9).

Described from the Barwon River estuary but has since been found to occur widespread in Victorian estuarine conditions (Apthorpe 1980; pers. obs.). Collins was doubtful as to the generic placement as his specimens did not have an obvious aperture and he suggested that interstices between the sand grains on the distal face may have acted as such. Most specimens from the Inlet have a terminal elongate aperture but rare specimens are inaperturate as Collins' type but are otherwise indistinguishable. Juvenile specimens are common in the Inlet, i.e. specimens consisting of only the initial slightly trochospiral coil; these always show an elongate equatorial aperture.

Ammobaculites exiguus Cushman and Brönnimann (1948).

This species is easily distinguished from *A. barwonensis* in its slender linear segment, more definite sutures and a circular terminal aperture. Juveniles of only the initial whorl differ from those of *A. barwonensis* in being planispiral and have a circular aperture.

Ammoscalaria sp.?

In sample 26, near the entrance to the Inlet, were found rare specimens of a large, planispiral species with a circular aperture but which differed significantly from *A. exiguus* in size, well impressed sutures and rougher surface. No specimens were found with a linear segment. These specimens seem to be closely allied to *Ammoscalaria runiana* found on the west coast of Scotland (Heron-Allen and Earland 1916) and in the Gullmar Fjord, Sweden (Hoglund 1947).

Textularia porrecta Brady (1884) (Fig. 4.11).

Small specimens were found in Group B samples.

Trochammina sorosa Parr (1950) (Fig. 4.12).

Rare specimens only in sample 25.

Trochammina inflata Montagu (1808) (Fig. 4.14).

Living specimens were uncommon, but fresh-looking unweathered forms were frequent in Top Lake. It seems to be tolerant of low salinities and muddy substrates.

Martinotiella sp. (Fig. 4.13).

Test agglutinate; elongate, slender, cylindrical, slightly arcuate; a short triserial or trochospiral section initially is followed by either two or four biserial chambers and then a long uniserial section. Chambers are wider than high (about 3:1), sutures depressed and well defined. Wall of test formed of moderate sized grains set in a fine groundmass, smooth surface. Aperture terminal, rounded and set flush or in a slight depression. Size: length - up to 0.45 mm; width - 0.1 mm.

In Top Lake (sample 8) there occurred specimens referred here to *Martinotiella* sp. This genus has been recorded previously in Victorian inlets; Collins (1974) refers to *M. primaeva* near the entrance to Port Phillip Bay and Apthorpe (1980) to *M. cf. communis* from the Gippsland Lakes.

The present specimens differ from *M. primaeva* which has a long biserial section and an elongate aperture on a slender apertural neck, and from *M. communis* in which the early chambers are fusiform with 4-5 chambers in the early whorls (Cushman 1937); both these species are also characteristic of very deep water (Cushman 1937).

The Mallacoota specimens seem to be close to that figured by Apthorpe (1980) for the Gippsland Lakes but, at present, the nomenclature is left open until more specimens are available for study.

Calcareous species

Spiroloculina aequa Cushman (1932).

One live specimen was found in sample 25 near the entrance. Collins (1974) recorded this species from beach sands at Barwon Heads. Live specimens have been

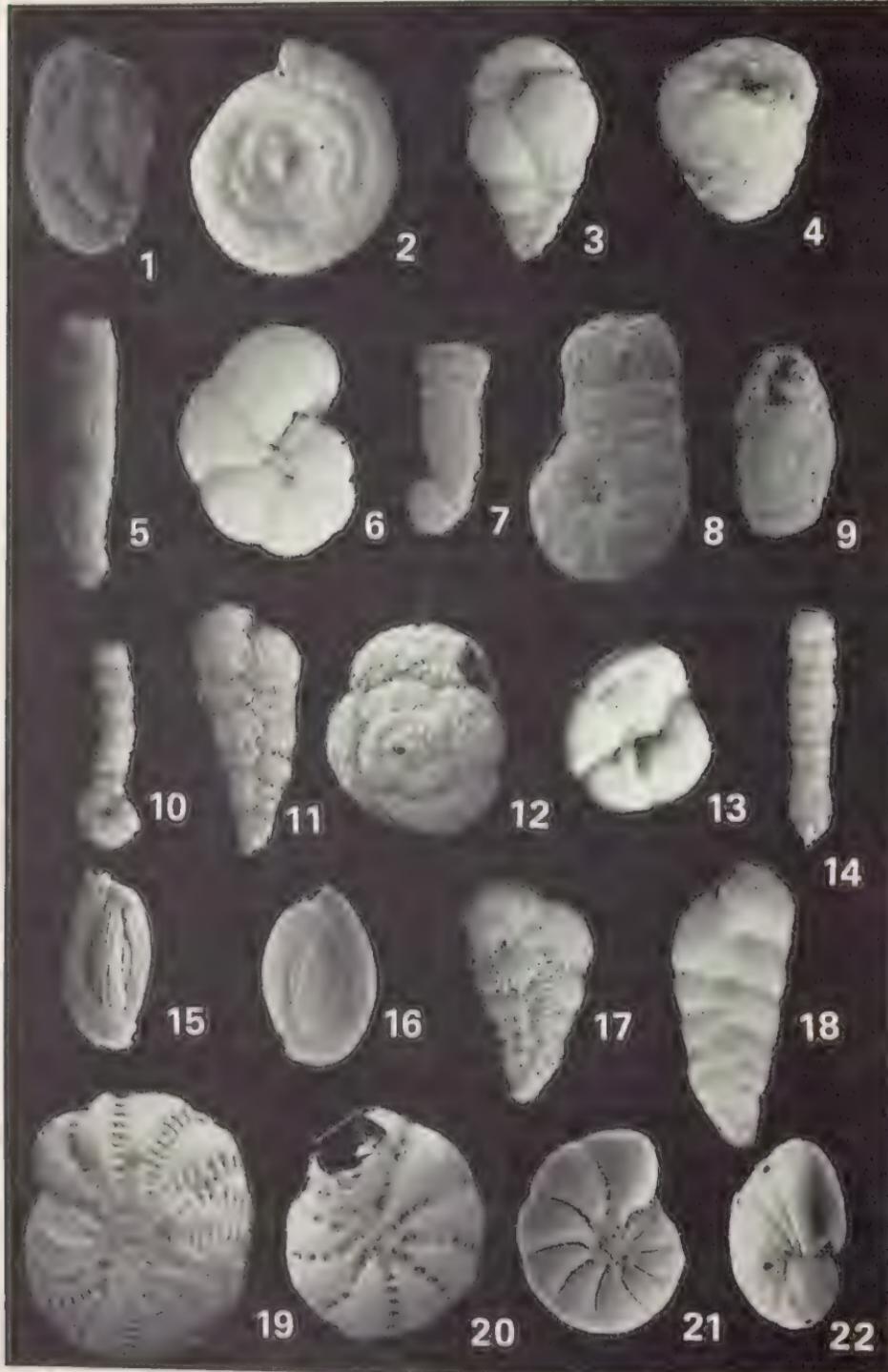


Fig. 4.

Fig. 4.

(1) *Miliammina fusca* x100; (2) *Ammodiscus mestayeri* x200; (3) *Eggerella subconica* x150; (4) *Eggerella polita* x120; (5) *Reophax barwonensis* x100; (6) *Haplophragmoides pusillus* x120; (7) *Ammobaculites barwonensis* x50; (8) *A. barwonensis* x150; (9) *A. barwonensis* x120, apertural view; (10) *Ammobaculites exiguum* x50; (11) *Textularia porrecta* x200; (12) *Trochammina sorosa* x200, last chamber broken; (13) *Martinottiella* sp. x120; (14) *Trochammina inflata* x100; (15) *Quinqueloculina poeyana* x50; (16) *Quinqueloculina seminula* x100; (17) *Bolivina pseudoplicata* x120; (18) *Bolivina compacta* x150; (19) *Elphidium depressulum* x100; (20) *Elphidium poeyanum* x200, last chamber broken; (21) *Elphidium simplex* x120; (22) *Nonionella auris* x100.

found in Western Port living on an algal slime (pers. obs.).

Sigmoilina australis Parr (1932).

Rarely found in estuarine waters as it is characteristic of fully open marine conditions. When present in enclosed waters it is only present near the entrances (Port Phillip Bay, Collins 1974; Western Port, Bell in prep.).

Bulimina gibba (Fornasini 1902)

Very rare specimens occurring near the entrance are placed in this species. They are similar to that figured by Albani (1979) but have slightly more globose chambers.

Bolivina pseudoplicata Heron-Allen and Earland (1930) (Fig. 4.17).

Previously recorded in Victoria from the Gippsland Lakes (Apthorpe 1980) and Barwon Heads (Parr 1945). The degree to which the posterior ridges on each chamber are developed varies greatly producing some almost smooth specimens whilst others have large re-entrants.

The genus Elphidium

In recent years this genus has been broken up into many new genera based upon characters which are variable and of doubtful generic (but possibly of specific) value (Hansen and Lykke-Andersen 1976). In this listing we have used the genus *Elphidium* sensu lato and placed all species present in it.

Elphidium argenteum Parr (1945).

The silvery sheen of the surface of this species is a useful aid in identification. It occurs in Bass Strait and the lower parts of Port Phillip Bay with rare specimens in the northern parts of Port Phillip Bay (Collins 1974), but had not been recorded elsewhere in Victoria.

Elphidium gunteri corioense Collins (1974).

Described from Port Phillip Bay; recorded from N.S.W. (Albani 1979) as an *Elphidiella* but *Elphidiella* has areal apertures as well as the row of small pores at the base of the apertural face; as the present specimens do not have these areal apertures they are placed in *Elphidium*.

Elphidium poeyanum d'Orb. (1839) (Fig. 4.20).

A small, compressed, smooth species with short retral processes and a depressed umbilical area. Specimens were rare and confined to the more saline samples.

Elphidium simplex Cushman (1933) (Fig. 4.21).

When present occurs only as infrequent specimens.

Nonionella auris d'Orb (1839) (Fig. 4.22).

Two specimens only were found. It is known from N.S.W. (Albani 1979).

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French Island and its Orchids

Report of a talk given by Gary Backhouse to the General Meeting of the FNCV at the Herbarium on 10th September 1990.

Introductory remarks about French Island

Gary had been associated with French Island as a staff member of the Department of Conservation and Environment since 1982. French Island is approximately 20 km long and 12 km wide, with an area of 17,000 hectares, and probably a lot more when mudflats emerge at low tide. Over half the island is included in the French Island State Park. The remainder is privately owned. There is a small resident population of 40 to 50 people. Thirty people own land on the island and visit from time to time. The island is generally flat and featureless, being mostly 30 m above sea level, whilst the highest point reaches 70 m above sea level. About two thirds of the island is still covered with native vegetation, including extensive heathlands and wetlands.

The bird life

Because of its inaccessibility and varied habitats, the island is a naturalist's paradise. Over 260 different species of birds, including many sea birds, migratory waders and bush birds, have been recorded from the area. Notable are the

two pairs of White-breasted Sea Eagles.

The Australian Pelican is permanent with regular annual breeding colonies on the island. In the tidal salt marshes there are mangrove flats and very good swamps which support breeding water birds like ibis, cormorants and herons.

Koalas

Koalas were introduced to French Island in the late 1800's. Less than 200 hectares are suitable habitats for koalas. The population is free from *Chlamydia* (a disease reducing fertility), and doubles every three years or so, causing the defoliation of the Manna Gums (*Eucalyptus viminalis*) on the island. Excess numbers are captured and relocated elsewhere.

Orchids through the seasons

Some 78 species of orchids have been identified so far on the island. The various species which have been observed will be described below, in the consecutive seasonal phases in which they appear. Their flowering periods are summarised in the table provided.

Early Autumn

Following the first autumn rains in March or April, the very small midge orchids appear. Formerly referred to as the genus *Prasophyllum*, they are now referred to as *Genoplesium*. Species include *Genoplesium despectans* (long acuminate and lanceolate lateral septae and labelllum); *G. morrisii* (very long cilia fringing the dorsal sepal, petals and irritable labellum, the perianth 4–6 mm long and blackish-purple); *G. parviflorum* (broadly deltoid to almost orbicular labellum, with the lateral sepals more or less connate toward the base) and *G. nigricans* (the Dark Midge Orchid, with a diamond-shaped labellum for about two thirds its length) are representative species.

Contemporaneously can be seen the Fringed Hare Orchid (*Leptoceras fimbriatum*), and Parson's Bands (*Eriochilus cucullatus*). In the case of the latter, the flowers emerge and die before the leaves appear.

Late Autumn

By the month of May, bird orchids and greenhoods appear for the first time. The genus for bird orchids is *Chiloglottis*. The Autumn Bird Orchid (*Chiloglottis reflexa*) can occur as early as February if there is rain then. Two flat lying leaves with slightly crinkled, wavy edges send up an 8 cm stalk, which supports a flower with a velvety, dark red tongue. The Common Bird Orchid (*C. gunni*), flowers in spring and has two flat, smooth-edged leaves.

The greenhoods, Tiny Greenhood (*Pterostylis parviflora*), and Prawn or Tailed Greenhood (*P. pedoglossa*), become common as winter approaches.

Pterostylis parviflora has at least three tiny flowers in the scape. The head is more or less 1 cm long, and the leaves are rarely present at flowering time.

Pterostylis pedoglossa by contrast, has a rosette of leaves at the base, whilst the head can be up to 1.5 cm long.

Early Winter

Once winter rains fall, there are more and more greenhoods, accompanied by

gnat orchids. Common greenhoods are the Banded Greenhood (*P. vittata*), the Striped Greenhood (*P. alata*), the Tall Greenhood (*P. longifolia*) the Dwarf Greenhood (*P. nana*), the Blunt Greenhood (*P. curta*), and the Nodding Greenhood (*P. nutans*).

The Common Gnat Orchid (formerly *Acianthus exsertus*, now *Cyrtostylis exsertus*) has flowers that are as small as gnats, which they resemble. It has one heart-shaped dark-green leaf with a reddish under surface. A related species is the May-fly Orchid (*C. caudatus*), growing in more shady places, emitting a wet dog odour so attracting a fungus gnat to pollinate it. The leaf is more crimped and irregular in shape. The Mosquito Orchid (*C. reniformis*) appears in late winter as a prelude to spring.

Mid-Winter

In June and July helmet orchids appear. *Corybas* grows on damp ground under dense vegetation, and quickly dries out in the wind. The systematics of this group has changed recently. The Slaty Helmet Orchid (*Corybas incurvis*) has a curved rim on the labellum. The species needs damp, still conditions to flower properly. The Veined Helmet Orchid is now *C. diemenicus*.

Fordham's Helmet Orchid (*C. fordhami*) grows under *Melaleuca squarrosa*. The dorsal sepal folds forward and obscures the labellum. It grows singly with a tiny vestigial leaf.

Late Winter

The Bearded Greenhood (*Pterostylis plumosa*) has a characteristic bearded labellum or tongue and is very attractive to look at. *Corybas unguiculatus* can be compared with *C. fordhami* in having a bulbous, dorsal sepal in the labellum, and grows in eucalypt woodland.

Donkey orchids begin to appear, for example the Leopard Orchid (*Diuris maculata*) has two large ear-like petals, spotted like a leopard. The Wallflower Donkey Orchid (*D. longifolia*) has strikingly large flowers, on slender stalks, of usually rich yellow and brown.

The Lizard Orchid (*Burnettia cuneata*) only grows in Scented Paperbark (*Melaleuca squarrosa*) swamps, being leafless, though with tiny green pigment in the stem. The orchid is a saprophyte, only flowering after bushfires. Burnt swamps are rare, so two to three years after a fire there's no sign of it.

Spring

The Common Onion Orchid (*Microtis unifolia*) grows in disturbed habitats. Its seeds germinate rapidly. The Common Bird Orchid (*Chiloglottis gunni*) grows in open forest and woodland. The Wallflower Donkey Orchid, formerly *Diuris longifolia*, is now known as *Diuris corymbosa*. It is very attractive, probably being pollinated by insects by accident like the *Diuris maculata* which imitates bush peas with which it is associated (Beardsell *et al.* 1986).

Pink Fairies (*Caladenia carneae*) is a pale to deep pink or even red in some cases, growing about 10 cm high usually with one or two flowers and rarely up to four.

The Thick-lipped Spider Orchid (*C. clavigera*) is also known from Anglesea and Wilson's Promontory.

The Black-tongued Caladenia (*C. congesta*) has the mid-lobe of the labellum completely covered by two rows of tightly packed reddish-black calli, especially crowded onto the end of the labellum. This orchid favours woodland on heavy soils.

The Blue Fairy Orchid (*C. deformis*) grows up to 10 cm tall, with a solitary blue flower, whose labellum, 1.5 cm long is a mass of tufted calli. It is therefore sometimes described as the Blue Beard Caladenia.

The Green-comb Spider Orchid (*C. dilatata*) grows up to 15 cm high. The flower can be up to 10 cm across, usually green, yellow, or maroon, and red-striped segments up to 5 cm long. The labellum is green, red, maroon, and yellowish-white, movable, trilobed, with a hood 2-3 cm wide, and recurved about the middle. The lateral lobes are erect, green, and deeply

combed or fringed. It is likely there are two or three different species in this taxon.

The Musky Caladenia (*C. gracilis*) has a distinctive hooded flower.

Pink Fairies, or Sugar Candy Caladenia (*C. latifolia*) is common on the coastal sand dunes, and is characterised by the lateral lobes of the labellum being barred with pink. The central lobe has a few long lateral teeth and a pink central blotch. The calli are rather irregularly arranged in two converging rows.

The Hare or Rabbit Orchid (*C. menziesii*), with pink and white flowers, has lateral petals about twice as long as the sepals. The petals are erect, clavate, and dark reddish, about 2 cm long. The sepals are broad, the dorsal one being hooked. The labellum is ovate, about 7 mm long, with entire margins. The column is barred with transverse, pink striae. This *Caladenia* is best seen following a hot summer bushfire.

The Pygmy Caladenia (*C. pygmaea*) grows less than 10 cm high with flowers just a few mm long, and flowers later than *C. carneae*, as well as other unnamed ones which are likely to be endemic to the island.

The Bronze Caladenia (*C. iridescens*) is not really iridescent. Being 10-20 cm high, with a purplish stem, and a small bract around the middle, the plant is subtended by a narrow leaf 5-10 cm long. The plant carries from one to four flowers, each being 2 to 2.5 cm diam. and strikingly coloured from reddish and golden tints to purplish crimson and green tips. Its prominent labellum is trilobed, with entire margins, red transverse markings and stalked black knobs.

Late Spring

Late spring is the time for leek orchids (*Prasophyllum*), sun orchids (*Thelymitra*), beard orchids (*Calochilus*) and the Wax-lip Orchid (*Glossodia major*).

The Tall Leek Orchid (*Prasophyllum elatum*) can have up to 100 flowers crowded on the spike, which are upside down on the stem. The plant can grow up

to over 1 m high, but normally ranges between 40 and 80 cm in height.

The Austral Leek Orchid (*P. australe*) grows in swampy heathlands and is more slender, growing to 50 cm, the leaf lamina being shorter than the inflorescence.

The Scented Leek Orchid (*P. odoratum*) so called because of its faint spicy odour, is a lowland or hill plant, 50–70 cm high. The sepals are always free and curved, the petals being slightly shorter, with less pink tonings and a brownish stripe along each.

The Slender Leek Orchid (*P. parviflorum*) usually has less than 50 flowers on the spike, with petals green or brownish, and streaked with red. The flowers are widely spaced along the spike, with all floral segments less than 4 mm. The labellum has a prominently raised callus, and is wholly green.

Lyperanthus is a genus of terrestrial herbs having fleshy tubers. It has a solitary basal leaf, which is long and narrow, or broad and thick. The dorsal sepal is broad and hooded, whilst the other segments are narrow.

The Red-beak Orchid (*L. nigricans*) needs summer fire to flower. It grows also in the Pines Reserve at Frankston. It is a stout plant 25 cm high, and dries black, hence its species name.

The Brown-beak Orchid (*L. suaveolens*) is a graceful, robust, and glabrous terrestrial growing up to 40 cm high. It grows among heath with a woodland overstorey, also in the Dandenongs.

The Wax-lip Orchid (*Glossodia major*) grows up to 25 cm high, subtended by a solitary, basal broadly lanceolate or oblong leaf, 8 cm long, arising from plump tubers. It has one striking usually purple or mauve flower, rarely there are two. Occasionally there is a white form, and rarely a double white form. Large colonies are often found in lightly timbered areas or in scrubland.

Beard Orchids (*Calochilus*) is a group of slender, robust terrestrials, with ovoid tubers. Each species has a solitary, channelled, linear leaf, and a leaf-like bract. Flowers are variable in number

carried upon a loose raceme. Dorsal sepals are erect, concave and broad. The lateral sepals spread, whilst the petals are shorter than the sepals. The labellum is most prominent, being longer than the other segments and densely-bearded, with long reddish-purple or brown hairs.

The Copper-beard Orchid (*C. campestris*) has reddish brown to purple hairs on the labellum. The Red-beard Orchid (*C. paludosus*) has reddish hair tufts right along the labellum.

Brown-beards or Purplish-beard Orchid (*C. robertsoni*) has eyes, which are hair tufts with yellow tips on the hairy labellum.

Sun Orchids (*Thelymitra*) –

This genus of orchids has ovoid tubers. A solitary elongated, narrow, fluted, or channelled leaf, subtends colourful flowers, the differentiation of which is the basis for their classification. They need sunny or warm weather for the flowers to open – hence the name – “Sun Orchid”. They are self pollinating.

Rabbit Ears (*Thelymitra antennifera*) is 10–25 cm high, with a rather long, linear and channelled leaf, subtending a stem with two angled bracts. One to three, rarely more, pale to deep yellow flowers, have a red stripe outside. Each flower opens freely and can be more than 1 cm across, smelling like a rose. The two prominent appendages in the centre of the flower account for the specific name.

Scented Sun Orchid (*T. aristata*) grows to waist height. The stem is as thick as your thumb, with about 40 blue flowers or more. The blue flowers have white hair tufts on the column.

Pink or Tiny Sun Orchid (*T. carnea*) needs a warm, sunny day to open the flowers which are less than 1.5 cm wide, with smooth column appendages.

The Blotched Sun Orchid (*T. benthamiana*) (was formerly *T. fusco-lutea*) is a stout, robust plant, 15–40 cm high arising from sub-globose tubers. It has one of the widest leaves of the Thelymitras, up to 12 cm long and 5 cm wide, being ovate-

Contributions

lanceolate and sheathing. There are one to two stem bracts. There are two to six flowers in the raceme, each flower being 2.5 cm across. Colour is yellowish green to brown blotches to yellow with reddish blotches with spots on rather long stalks.

The Twisted Sun Orchid (*T. flexuosa*) can be compared with *T. antennifera*. It grows up to 15 cm high, with a wiry, rather zig-zagging stem. The leaf is short, up to 6 cm, terete and stem-clasping below. Flowers are one to three, small, yellow, and with obtuse perianth segments, growing well in sandy heathlands.

Thelymitra holmesii has a circular yellow apex to the column, with white hair tufts.

The Dotted Sun Orchid (*T. ixioides*), slender and somewhat robust, grows between 20 and 50 cm high, with a narrow channelled leaf up to 12 cm long. Flowers nine to ten in number are on slender stalks, usually blue or mauve, but sometimes violet, purple-blue, pink or white. The three upper segments (dorsal, sepal and petals) are always spotted. Flowers are 3 cm across.

The Slender Sun Orchid (*T. pauciflora*) ranges between 10 and 45 cm high. Leaf is thick and fleshy, but variable in length. Up to three stem bracts. Flowers are star-shaped varying from three to twelve, but rarely 15. They open up to 2 cm diam., but require very hot weather to do so. They vary in colour from white, mauve, pale to medium blue, purple and pink. Flowers are short lived and self pollinating.

Late Spring to Summer

The last of the orchids to flower include the duck orchids, onion orchids, Potato Orchid (Cinnamon Bells), Horned Orchid, Hyacinth Orchid and the Small Tongue Orchid.

The Large Duck Orchid (*Paracaleana major*) grows in dry heaths in woodland. Being 15-30 cm high, on a wiry, reddish-brown stem, the duck-like head is very distinctive.

The Small Duck Orchid (*Paracaleana minor*) varies in height between 6-15 cm

and is much smaller with up to three flowers, but rarely up to seven. Again the duck shape is very distinctive and smaller.

Yellow Onion Orchid or Swamp Leek Orchid (*Microtis atrata*) is only 5 or 6 cm high with tiny flowers which blacken on drying.

Sweet Onion Orchid or Scented Leek Orchid (*M. oblonga*) (was *M. orbicularis*) has a slender spike with rather widely-spaced fragrant flowers. The lateral sepals are tightly revolute.

Cinnamon Bells (*Gastrodia sesamoides*) is a saprophyte on a Basidiomycete fungus which it grows with. It is also known as the Potato Orchid. The underground tuberous rhizomes resemble small Jerusalem Artichokes (Bates & Weber 1990).

Summer

The Horned Orchid (*Orthoceras strictum*) lives in heaths and heathy grasslands and flowers best from November to January.

The Hyacinth Orchid (*Dipodium punctatum*) is also known as the Spotted Orchid. It is epi-parasitic on Messmate (*Eucalyptus obliqua*), thriving after bushfires. It is leafless and varies from 30 cm to 1 metre high. It has 20 to 40 flowers on a 30 cm raceme.

The Small Tongue Orchid (*Cryptostylis leptochila*) is pollinated by a male Ichneumonid Wasp (*Lissopimpla semi-punctata*) as the flower imitates the female of this wasp species. Likewise the Large Tongue Orchid (*C. subulata*) is pollinated similarly. Both are swamp growing and flower well into summer.

Members were most impressed with the detail and coverage of Gary's slides, together with the detail given on orchid habitats and associations. The chairman expressed gratitude to Gary in giving up his time to present members with an up-to-date and comprehensive account of the orchids on French Island.

Noel Schleiger
Arthur Farnworth

Contributions

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Orchid species	Common name	J	F	M	A	M	J	J	A	S	O	N	D
<i>Genoplesium despectans</i>	Sharp Midge Orchid	●	●	●	●								
<i>Genoplesium morrisii</i>	Bearded Midge Orchid		●	●	●								
<i>Genoplesium parviflorum</i>	Slender Midge Orchid		●	●	●								
<i>Genoplesium nigricans</i>	Dark Midge Orchid		●	●	●								
<i>Leptoceras fimbriatum</i>	Fringed Hare Orchid			●	●	●	●	●	●	●	●		
<i>Eriochilus cucullatus</i>	Parson's Bands	●	●	●	●	●							
<i>Chiloglottis reflexa</i>	Autumn Bird Orchid		●	●	●	●	●	●	●	●	●		
<i>Pterostylis parviflora</i>	Tiny Greenhood	●	●	●	●	●	●	●	●				
<i>Pterostylis pedoglossa</i>	Tailed Greenhood		●	●	●	●	●	●					
<i>Pterostylis vittata</i>	Banded Greenhood					●	●	●	●	●	●		
<i>Pterostylis alata</i>	Striped Greenhood					●	●	●	●	●	●		
<i>Pterostylis longifolia</i>	Tall Greenhood					●	●	●	●	●	●		
<i>Pterostylis nana</i>	Dwarf Greenhood					●	●	●	●	●	●		
<i>Pterostylis curta</i>	Blunt Greenhood						●	●	●	●	●		
<i>Pterostylis nutans</i>	Nodding Greenhood						●	●	●	●	●		
<i>Cyrtostylis exsertus</i>	Common Gnat Orchid				●	●	●	●	●				
<i>Cyrtostylis caudatus</i>	Mayfly Orchid									●	●		
<i>Cyrtostylis reniformis</i>	Mosquito Orchid					●	●	●	●	●	●		
<i>Corybas incurvus</i>	Slaty Helmet Orchid					●	●	●	●	●	●		
<i>Corybas diemenicus</i>	Veined Helmet Orchid						●	●	●	●	●		
<i>Corybas fordhami</i>	Fordham's Helmet Orchid						●	●	●				
<i>Pterostylis plumosa</i>	Bearded Greenhood						●	●					
<i>Corybas unguiculatus</i>	Spurred Helmet Orchid					●	●	●	●				
<i>Diuris maculata</i>	Blotched Leopard Orchid							●	●	●	●		
<i>Diuris corymbosa</i>	Donkey Orchid								●	●	●		
<i>Chiloglottis gunni</i>	Common Bird Orchid								●	●	●		
<i>Burnettia cuneata</i>	Lizard Orchid								●	●	●	●	
<i>Microtis unifolia</i>	Onion Orchid	●								●	●	●	

Contributions

Orchid species	Common name	J	F	M	A	M	J	J	A	S	O	N	D
<i>Caladenia carneae</i>	Pink Fairies								●	●	●	●	●
<i>Caladenia clavigera</i>	Thick-lipped Spider Orchid								●	●			
<i>Caladenia congesta</i>	Black-tongued Caladenia								●	●	●		
<i>Caladenia deformis</i>	Blue Fairies						●	●	●	●	●		
<i>Caladenia dilatata</i>	Green-comb Spider Orchid	●							●	●	●		
<i>Caladenia gracilis</i>	Delicate Caladenia								●	●			
<i>Caladenia latifolia</i>	Sugar-candy Caladenia								●	●	●		
<i>Caladenia menziesii</i>	Hare or Rabbit Orchid							●	●	●	●		
<i>Caladenia pygmaea</i>	Pygmy Caladenia								●	●			
<i>Caladenia iridescens</i>	Bronze Caladenia								●	●	●		
<i>Prasophyllum australe</i>	Austral Leek Orchid									●	●		
<i>Prasophyllum elatum</i>	Tall Leek Orchid								●	●	●		
<i>Prasophyllum odoratum</i>	Scented Leek Orchid								●	●	●		
<i>Prasophyllum parviflorum</i>	Slender Leek Orchid								●	●	●		
<i>Lyperanthus nigricans</i>	Red Beak Orchid								●	●	●		
<i>Lyperanthus suaveolens</i>	Brown Beak Orchid								●	●	●		
<i>Glossodia major</i>	Wax Lip Orchid								●	●			
<i>Calochilus campestris</i>	Purple Beard Orchid								●	●	●		
<i>Calochilus paludosus</i>	Red Beard Orchid								●	●	●		
<i>Calochilus robertsoni</i>	Brown Beard Orchid								●	●	●		
<i>Thelymitra antennifera</i>	Rabbit Ears								●	●	●		
<i>Thelymitra aristata</i>	Scented Sun Orchid							●	●	●			
<i>Thelymitra carnea</i>	Pink or Tiny Sun Orchid								●	●			
<i>Thelymitra benthamiana</i>	Blotched Sun Orchid								●	●	●		
<i>Thelymitra flexuosa</i>	Twisted Sun Orchid								●	●	●		
<i>Thelymitra holmesii</i>	Holmes' Sun Orchid								●	●	●		
<i>Thelymitra ixoides</i>	Dotted Sun Orchid								●	●	●		
<i>Caleana major</i>	Large Duck Orchid										●	●	
<i>Caleana minor</i>	Small Duck Orchid	●									●	●	
<i>Microtis atrata</i>	Yellow Onion Orchid										●	●	
<i>Microtis oblonga</i>	Sweet Onion Orchid										●	●	
<i>Gastrowia sesamoides</i>	Cinnamon Orchid	●	●							●	●	●	
<i>Orthoceras strictum</i>	Horned Orchid	●	●								●	●	
<i>Dipodium punctatum</i>	Hyacinth Orchid	●	●	●	●	●	●					●	
<i>Cryptostylis leptochila</i>	Small Tongue Orchid	●	●	●	●							●	
<i>Cryptostylis subulata</i>	Large Tongue Orchid	●	●	●								●	

Notes from the National Herbarium of Victoria No. 10

The Names of Plants — In Pursuit of the Correct Name

Ian Clarke*

This is the second in a small series of articles dealing with aspects of plant nomenclature. The first appeared in Vict. Nat. vol. 108 (5). An understanding of the contents of the previous article, while perhaps not essential, has been assumed. This series is part of an ongoing occasional series from the National Herbarium of Victoria.

Whether amateur or professional and from whatever background, people interested in plants often feel a sense of frustration over name changes. These changes are sometimes thought, incorrectly, to be the misguided whims of taxonomic botanists. In fact they reflect the serious attempt by "Botanical Science" to classify and name the inhabitants of the vegetable kingdom, and as our understanding is refined and extended so are revisions and changes inevitable. Pursuing this process to a logical conclusion, one can conceive a time in the future when changes will become less and less common.

The following notes describe the often difficult course a name must chart in order to be accepted as "correct", and point out some of the reasons why name changes occur. The discussion concentrates on the names of "species" as the basic unit in plant classification, however the general principles outlined often have a broader application to other ranks as well. It should be remembered that the name of a species consists of the combination of two words — the generic name and the specific epithet. Species names are often referred to as binomials.

The naming of plants is governed by the International Code of Botanical Nomenclature (ICBN). The Code is made up of six principles, and numerous articles (rules) and recommendations. The fourth

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Birdwood Avenue, South Yarra, 3141.

principle, expressed simply, states that a particular kind of plant can have only **one correct name**. Unfortunately many kinds of plants, during the past several hundred years of botanical endeavour, have received more than one name. Because of this, a large part of the Code deals with the problem of answering the question, "Which one is correct?"

Australian botany has suffered much in this regard as so many of the early collections were sent back to Europe for study and naming. Botanical science in the colonies did not get underway until the appointment of Ferdinand Mueller as Victorian Government Botanist in 1853. The doubling-up of names is graphically illustrated by figures published in two recent texts. The Australian Plant Names Index (Chapman, 1991), which attempts to include every name ever published for Australian vascular plants, lists 37,900 species names. In contrast, the Census of Australian Vascular Plants (Hnatiuk, 1990) includes less than half of these, (17,590) as names of currently recognised species.

This situation has come about in two main ways. Firstly, many superfluous names have been published through an author being unaware of previously published available names, particularly in the past when communication was not as easy or rapid as it is today. Secondly, many names were given to "species" based on the examination of relatively few specimens. Later botanists, having a greater range of material to work with, have often

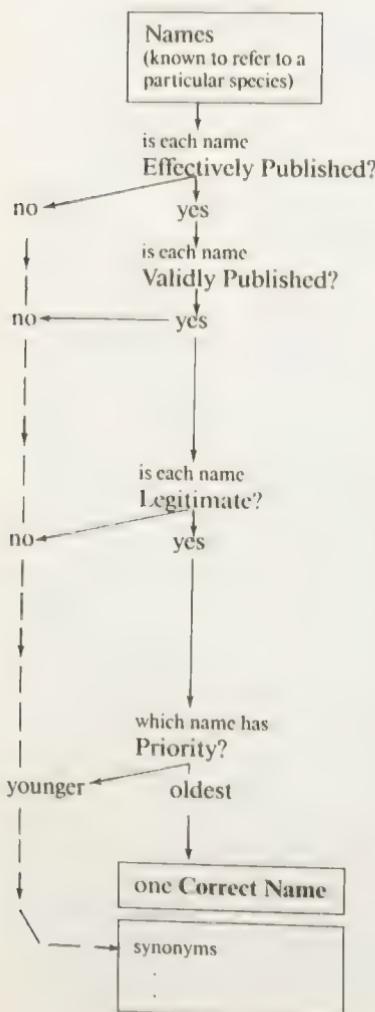
Contributions

been forced to reconsider the extent of variation acceptable within one species and, as a consequence, have united two or more species under the one correct name.

Of course, the reverse situation also occurs, where what was previously accepted as one "variable species" is subsequently recognised as a number of species. Often botanists are aware of "problem species" such as these that are

simply waiting their turn for revision in the light of current knowledge. For the time being the name applied may be the most appropriate one available.

To be eligible for contention as correct, a name must satisfy the various conditions laid down in the ICBN, summarised in the accompanying diagram. If a name cannot proceed steadily downwards, following the vertical arrows, it cannot be accepted as the correct one.



Effective publication basically refers to the necessity for properly distributed, printed matter (i.e. not a handwritten manuscript).

Valid publication involves a number of technical requirements, in particular, the new name must be accompanied by a latin description or diagnosis (a statement enabling it to be distinguished from known species), an indication of the name's rank, and the designation of a Type Specimen.

To be legitimate, a name must be "in accordance with the rules". These include, besides the above, a number of other conditions, e.g., the name (binomial) must not have been used before for another species, and it should not be superfluous to requirements (i.e., it must be needed, there being no other available name).

Priority – the earliest legitimate name for a species (i.e., the first published of those that have progressed down the chart) has priority over all other later names.

The detailed meanings of Effective Publication, Validity, Legitimacy and Correctness can be followed up in the accompanying references; the notes beside the diagram should be taken as a guide.

The application of the rule of priority necessitates detailed literature searches, and has often resulted in a familiar name being replaced by one overlooked and long forgotten. With the advent of computers and databases, proposals have been put forward to establish a "world list of current, accepted plant names". This would set a new starting point for accepted names; any obscure names not listed would not be considered in decisions relating to priority. This issue remains unresolved.

The names relegated to synonymy as a consequence of botanical revisions, even though not correctly used for a particular kind of plant, nevertheless are still important. A substantial amount of information may be embodied in the literature under the various synonyms, and for this reason botanists expend time and energy establishing accurate lists called 'synonymies'. These ensure that all relevant information can be readily accessed.

It must also be recognised that names are dependent on classification. To a certain extent this is a matter of botanical opinion. One author may follow a classification that proposes a broad concept of a particular group and adopt the appropriate names, while another author may follow a different classification proposing a narrower concept that requires changes to some of the names. Both sets of names can be correct within the context of their respective classifications. Which names one should take up and use is then a matter of botanical judgement as to the soundness of the classification. The Census of the Vascular Plants of Victoria (Ross, 1990), now in its third edition, is often referred to as a standard list of names. The inclusion of proposed name changes for Victorian species in subse-

quent editions will necessitate such judgements by Herbarium staff.

In floras and reports and other technical literature, there is often an introductory statement to the effect that the nomenclature or classification adopted follows that of a recognised author. For example, at the level of families, the new Flora of Australia series (George, 1981) follows the classification scheme recently proposed by the American botanist Arthur Cronquist. One result of his broad concept of certain families, the Lilies (Liliaceae) for example, is that some genera traditionally included elsewhere by other authors are now included here.

The Flora of Australia series is providing a considerable stimulus to Australian taxonomic botany and by the time it is completed shortly after the turn of the century, all plant groups will have undergone some form of reappraisal if not major revision. There are still many gaps in our knowledge, as well as areas of the continent that await through botanical exploration, but the production of the Flora may well mark the beginning of a period of relative stability for the names of Australian plants.

Acknowledgements

Thanks are due to Jim Ross and David Albrecht for their comments on the manuscript.

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Third Spotted Tree Frog (*Litoria spenceri*) Search

Peter Robertson*

The third monitoring search for the Spotted Tree Frog, *Litoria spenceri*, held on Saturday and Sunday, 23-24 November 1991, was extremely successful. Weather conditions were ideal with a maximum temperature of 26 degrees C. and water temperatures between 14 and 15 degrees C.

The search was held in the vicinity of the Taponga River campground, reference NATMAP8123, AMG 158 626. Sections of the Taponga River, Still Creek, White Creek and the Big River were searched.

A total of 27 people assisted in the search, and apart from individual persons, they included members of the Department of Conservation and Environment, Victoria Herpetological Group, Ballarat Reptile Park and The Field Naturalists Club of Victoria.

Choruses of calling males were heard for

the first time, and 66 frogs were found by the searchers:

- 30 - calling male frogs
- 12 - male frogs not calling
- 5 - breeding female frogs
- 5 - sub-adults or individuals not sexed
- 14 - metamorphlings

No eggs or tadpoles were found, nor any of the frogs marked on the previous trips (November 1990 and February 1991).

Of the 66 individuals encountered, 47 were toe-clipped and released at the site of capture, 16 were recorded but not captured and toe-clipped and 3 died. These latter ones will be lodged in the Museum of Victoria. Many thanks to all who helped in the search.

*Department of Conservation and Environment, 123 Brown Street, Heidelberg, Victoria 3084.

Conservation Issues

Conservation Issues

In each publication we will keep you informed of current conservation and environmental issues which are relevant to the Club and its members.

We have been sent the following reports on which to comment. These are held in the office and members who are interested are invited to view them there, or by arrangement with the Conservation Co-ordinator, Julian Grusovin.

1. Port of Melbourne Authority: Victorian Ports Land Use Plan. Draft Final Report.
2. Department of Conservation and Environment: Baw Baw National Park Resources and Uses, and Proposed Management Plan.
3. Department of Arts, Sport, Environment and Territories: Questionnaire on Rainforest Conservation.
4. Department of Conservation and Environment: Request for information on mammal, frog, reptile and bird numbers for certain areas of Victoria.

Annual Report of the Microscopical Group of the FNCV April 1990 – March 1991

During the year attendance averaged 15 members and three visitors, per meeting. We have gained new members from the advertisements placed in *The Age* newspaper while others have attended as visitors.

Vale –

Fred Thorpe died 18th August 1990 while on holiday in Seattle, U.S.A.

Clifford Nance, a member of the FNCV for over sixty five years, died 1991, in his 93rd year.

Lectures for the year –

March 21	Mr Bock, lecturer in Bryozoans. Geology at RMIT	
April 18	Mr Dan McInnes	Pond life.
May 16	Members' Night.	Viewing slides in the Microscopical Collection showing slides of all subjects of interest to microscopists and the skills used in mounting various objects.
June 20	Dan McInnes	Protozoa.
July 18	Russell Ward	Plankton.
Aug. 15	Mr Ray Power	Polarised light.
Sept. 19		Members to prepare and exhibit a Pollen slide.
Oct. 17	M/s Christine Ashburner	Scanning Electron Microscope.
Nov. 21	Mr David Mellor	Leica Technical Consultant.
Jan. 16		Members' Night.
Feb. 20	Mr Dan McInnes	Fresh water microscopy.
March 20	Mr Urwin Bates & Mr John Dawes	Modulation Contrast Phase Contrast.

Donations

Miss Mary Doery made a personal gift of her old microscope she used as a student at Melbourne University.

Library Acquisitions

Superb photograph taken by Mr G. O'Loughlin from slide W328 in the Microscopical Collection. (Composition of 1000 pieces of butterfly scales of various colours.)

Inventory

As at May 1990, Mr McInnes had catalogued eight thousand slides in the Microscopical Collection and compiled a Catalogue (5 pages) of all the books on Microscopy in the Microscopical library.

Mr Dan McInnes is to be congratulated on his contribution in the *Victorian Naturalist*, Volume 107 (2) April 1990, pp 58–64, on Pond Life.

The group is under the capable leadership of Mr Urwin Bates.

Elsie C. Graham (Hon. Sec.)
Microscopical Group, FNCV 15/5/1991.

Annual Report of the Botany Group of the F.N.C.V. 1990

Members and friends who come to the monthly meetings and take part in the monthly excursions have again enjoyed a very interesting and varied year. We are sorry that more members of the FNCV in general do not take part in these activities – they are not planned only for experts, but if you read through the topics covered you will see that they appeal to anyone with an interest in natural history – and the excursions are always an excuse to enjoy a day in the bush with people of similar interests.

The topics for the 1990 meetings were:-

Feb.	Helen Aston	Aquatic Plants in Australia – their morphology, taxonomy, distribution and impact on the environment.
March	David Albrecht	Flora of Borneo and North Sumatra.
April	Hilary Weatherhead and members	Autumn flowers and fruits.
May	Dr Ross Field	The biological control of weeds.
June	Dr Patrick McCarthy	Lichens.
July	Arthur Thies	Mosses and Liverworts.
Aug.	Margaret Corrick	From Dalhousie Springs to Western Queensland.
Sept.	Dr David Cameron	Victoria's rainforests.
Oct.	Hilary Weatherhead	Oranges and Boronias: the family <i>Rutaceae</i> .
Nov.	Mary Doery	Botanical ramblings in France.
Dec.		A.G.M. and Members' Night.

The attendance at these meetings ranged from 14 to 41 (this includes 21 visitors) with an average of 22.

Excursions were:-

	leader	subject	location
Feb.	Helen Aston	Aquatic plants	Willsmere, Banyule, Warrigal.
March	Hilary Weatherhead	Mountain fruits/trees	Mt Donna Buang.
April	Stephanie Rennick	The vegetation	Zones of the Hastings Shire coast.
May	Tom May	Fungi	FNCV Kinglake property.
June	Dr Patrick McCarthy	Lichens	Sandy Bay area of Jumping Creek Reserve, Warrandyte.
July	Arthur Thies	Mosses and liverworts	Sassafras Ck, Kallista.
Aug.	Staff member	Tour	Royal Botanic Gardens, Cranbourne.
Sept.	Gary and Susan Clark and John Eichler	Plants	Pyrene Range.
Oct. Sat. (weekend)	Neville Scarlet	Rare grasslands plants re-establishment program	Mooramona, Skipton.

Reports

Oct. Sun.	E. and L. Courtney and Gary Cheers	Tour with Maryborough FNC	FNCV Cosstick Reserve and Paddy's Range State Park.
Nov.	Cecily Falkingham	Small reserves with problems	a.m. Hotchens Ridge Flora Reserve, Croydon North. p.m. Cheong Wild Flower Sanctuary, East Ringwood.

Numbers attending varied from 8 to 23, with the average being 15 (excluding the weekend.)

We are sad to have to report the death, on October 13, 1990 of one of our most regular attenders, Miss Laura White. She was 95. We all appreciated her keen mind, still keeping up with the many name changes in botany in recent years, and her vast knowledge of the plants of Victoria. She was at the monthly meeting on Tuesday, October 11, full of her usual enthusiasm, and died suddenly two days later.

Win Bennet (Hon. Sec.)
Botany Group, FNCV 17/2/1991

Obituary

Mr Clifford Nance

An Old Microscopist Passes On.

Clifford Alfred Nance died on the 17th March 1991 at the age of 92. He joined the Microscopical Society of Victoria in October 1920 at the age of 22 and retained his love of microscopy right through his life. Although his greatest love was botany, Cliff was one of the older generation of naturalists who had a very wide range of scientific knowledge. He was able to combine his knowledge of botany and chemistry to make botanical slides which were works of art. Many of these have been given to the FNCV for future generations to see. His skill in miniature engineering enabled him to make microscopical accessories which he generously shared with others.

Cliff will always be remembered for his quiet gentlemanly manner and for his willingness to share his great knowledge with others.

Note:- The Microscopical Society of Victoria was incorporated into the Field Naturalists Club of Victoria on the 7th June 1954 and 44 members of the Society were elected as members of the FNCV. On 15th June 1954 these members formed The Microscopical Group of the FNCV.

Mark Genery

Drawing on Nature

*Images and Specimens of Natural History
from the Collection of the Museum of Victoria*

Geelong Art Gallery	7 March - 12 April 1992
Benalla Art Gallery	18 April - 17 May 1992
Museum of Victoria	25 May - 25 June 1992

This exhibition opens at the Geelong Art Gallery on Friday 6 March at 5.30 p.m.

The exhibition curator, Paul Fox, has drawn upon the rich heritage of scientific prints, drawings, watercolours and specimens from the Museum of Victoria's collection to explore the different ways nature has been represented by artists and scientists. It is the first time many of the exhibits have been displayed.

There are more than seventy exhibits including work of the American wildlife artist J.J. Audubon; watercolours of insects by A. Bartholomew; N. Cayley's bird paintings; work of taxidermist and naturalist A. Coles and a specimen of the great Murray Cod which weighed 46.8 kilograms when captured in 1983.

Every Naturalist and nature lover will find this an enjoyable exhibition that should not be missed.

Entry fees to the Geelong and Benalla Art Galleries are \$1 for adults and 50 cents for concession holders. Entry to the Museum of Victoria is \$4 for adults and \$2 for concession holders and children.

1991/92 Victorian Roadsides Environment Awards

The Victorian Roadsides Conservation Committee is pleased to announce another round of the Victorian Roadsides Environment Awards.

These awards are to promote conservation management of linear reserves. Awards are given for outstanding examples of environmental activities or treatments on road and rail reserves which duly consider the natural, historic or landscape values.

Awards are available in five categories:

- * Natural Environment.
- Historic/Cultural.
- Environmental Care in Works.
- Promotion and Publications.
- Schools and Education.

Any organisation, community group, authority or individual is eligible to enter.

Further information and application forms are available from:

Anne Dennis
Executive Officer
R.C.C. Inc.
P.O. Box 41
East Melbourne 3002.

Ph. (03) 412 4653.

Closing date for applications is 30 April, 1992.

New members

Metropolitan

Mr N. Brown, Armadale
Mr B. Calvert, McKinnon
Ms V. Craigie, Northcote
Ms D. M. D'Costa, Mt Waverley
Ms C. Harvey, Kew
Ms S. Hurwitz, Brunswick
Ms J. Leveson, Essendon
Mrs O. Ouranidis, Bulleen

Mr T. W. Roxburgh, East Malvern
Ms K. Williams, Essendon
Mr S. Spillard, Caulfield North
Ms J. Davis, Montmorency
Mr P. Hanson, East Malvern
Ms L. Frigo, Altona
Ms K. Wilson, Oak Park

Joint Metropolitan

Mr K. Lovegrove, Mrs N. Lovegrove, Malvern
Ms J. Broadberry, Ms K. James, Templestowe
R. Whittle, Ms V. Legg, Heidelberg Heights
Mr J. Delpratt, Ms L. Heath, Richmond
Mr G. Radson, Mrs V. Radson, Bentleigh
Ms B. Saulenier, Ms A. Vendyoux, Heathmont
Ms M. Arundel, Mr P. Tucker, South Yarra

Country

Mr A. Pollock, Orbost
Mr J. Fisher, Portland
Mr C. Trainer, Maryborough

Honorary Membership, 1992

The following members have qualified for Honorary Membership.
They all joined in 1952.

Miss T. Coto, Heidelberg
Mrs C. Mcqueen, Wentworth Falls, NSW
Mr K. Parkin, Ivanhoe
Mrs K. Parkin, Ivanhoe

*The Season's Greetings were beautifully expressed by Jean Galbraith
in her card to the FNCV.*

Journey's End

The road runs on, and it well may be
There are hills to climb, and long vales between
May your hearts be strong and your glad eyes see
The mountain's vista, the valley's green.
And if the levels are dry and long
May you still have flowers, and a thrush's song
That, content at last, at the journey's end,
You may look back smiling "The hills were steep
But how fair the view!" I would not amend
The path I had. Though the vales were deep
I found wisdom there, and a steadfast friend
And life's chiefest joy at the journey's end.

Field Naturalists Club of Victoria

In which is incorporated the Microscopical Society of Victoria

Established 1880

Registered Office: FNCV, c/- National Herbarium, Birdwood Avenue, South Yarra, 3141 (650 8661).

OBJECTS: To stimulate interest in natural history and to preserve
and protect Australian fauna and flora.

Members include beginners as well as experienced naturalists.

Patron

His Excellency, The Rev Dr John Davis McCaughey, The Governor of Victoria.

Key Office-Bearers December 1991

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Group Secretaries

Botany: Mrs. WIN BENNET, 22 Echuca Road, Greensborough, 3088 (435 1921).

Geology: Mr. GRAEME LOVE (282 5187).

Fauna Survey: Ms FELICITY GARDE, 30 Oakhill Road, Mt. Waverley, 3149 (808 2625).

Microscopical: Mrs. ELSIE GRAHAM, 147 Broadway, Reservoir, 3073 (469 2509).

MEMBERSHIP

Membership of the F.N.C.V. is open to any person interested in natural history. *The Victorian Naturalist* is distributed free to all members, the club's reference and lending library is available and other activities are indicated in reports set out in the several preceding pages of this magazine.

Membership rates 1992

Metropolitan	\$30
Joint Metropolitan	\$35
Country/Interstate members	\$27
Joint Country/Interstate	\$32
Concessional rate (Students/pensioners)	\$22
Joint Concessional	\$27
Junior (under 18, no <i>Victorian Naturalist</i>)	\$5

Subscription rates 1992

Club subscription	\$30
Libraries within Australia	\$40
Overseas	AUD \$50

The Victorian Naturalist

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FNCV Calendar of Activities

May

Sat 2 - Sun 3 Fauna Survey Group Field Survey.
 Wilsons Promontory (post-fire ecology study).
 Contact Anne Casey, 380 8290.

Sun 3 General Group Excursion. Tootgarook Wetlands. Inspection of insect and fossil collection Stewart property.
 Contact Dorothy Mahler, 850 9379 or 435 8408.

Tues 5 Fauna Survey Group Meeting - Studies on the Rabbit Haemorrhagic Virus as a means of Biological Control of Rabbits: Harvey Westbury. Herbarium Hall 8 p.m.

Wed 6 Geology Group Meeting. Herbarium Hall 8 p.m.
 Contact Graeme Love, 282 5187.

Sat 9 Fauna Survey Group Field Survey. Leadbeaters Possum Survey.
 Contact Ray Gibson, 874 4408.

Mon 11 General Meeting - Travels through the Eastern Simpson Desert and Georgina Channel Country. An illustrated talk by Helen Aston covering plants, birds and history. Herbarium Hall 8 p.m.

Thurs 14 Botany Group Meeting - Botanical slides of Tasmania. Trevor Blake. Herbarium Hall 8 p.m.

Wed 20 Microscopy Group Meeting - Accessories for the Microscope - Old, New and Home-made. Astronomer's Residence 8 p.m.

Sat 23 Botany Group Excursion — Picnic Hill/Warburton. Leader Cecily Falkingham. Contact Joan Harry, 850 1347.

Sat 23 - Sun 24 Fauna Survey Group Field Survey. Yellow-bellied Gliders Survey at Mt. Cole. Contact Laurie Conole, 481 4926.

Sat 30 Fauna Survey Group Field Survey. Leadbeaters Possum Survey.
 Contact Ray Gibson, 874 4408.

June

Tues 2 Fauna survey Group Meeting - French Island: State or National Park? Its Conservation: Clive Gordes. Herbarium Hall 8 p.m.

Wed 3 Geology Group Meeting. Herbarium Hall 8 p.m. Contact Graeme Love, 282 5187.

Sat 6 - Mon 8 Fauna Survey Group field Survey. Wilsons Promontory (post-fire ecology study). Contact Anne Casey, 380 8290.

Sun 7 General Group Excursion. Mt. Toole-be-Wong. Leader Rod Barker. Contact Dorothy Mahler, 850 9379 or 435 8408.

Thurs 11 Botany Group Meeting - Fungi. Tom May. Herbarium Hall 8 p.m.

Sun 14 General Meeting. Herbarium Hall 2.p.m.

Wed 17 Microscopy Group Meeting - Diatoms: A display of type specimens of various species and slides from fossil areas.
 Astronomer's Residence 8 p.m.

Sat 20 Fauna Survey Group Field Survey. Leadbeaters Possum Survey.
 Contact Ray Gibson, 874 4408.

Sat 27 Botany Group Excursion - Fungi. Leader Tom May. Contact Joan Harry, 850 1347.

The Victorian Naturalist



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Cover Photo: (Macropus giganteus), Eastern Grey Kangaroo, taken at Zumsteins (Grampians), by Graeme Coulson. (See article on p.49.)

Marine Environment

It has long been appreciated by many naturalists and conservationists that marine and, to a lesser extent, coastal environments are poorly understood and managed, and inadequately represented in our system of conservation reserves. This is the case within Victoria as it is around the globe.

This being the case, it would seem proper and reasonable for an organization such as ours to involve itself in this area; to provide opportunities for naturalists and SCUBA divers to study and enjoy the marine environment, to make sound policy and to put this policy to government, and to take action which will assist in the conservation of marine ecosystems.

The Club has entered a consultative process with a variety of people involved in marine issues, to assist us in determining what role we can play in this field. There are several options for involvement which are consistent with the sort of work we already do:

- community education
- meetings hosting guest speakers
- recreational and interpretative nature study excursions
- survey work to determine biological values
- lobbying

These sort of activities are best organised through a special interest group. If you are interested in being involved in, and participating in such a marine group, we would like to hear from you and also hear your ideas on what you would like this proposed group to do.

Please write to the Club, c/- National Herbarium, Birdwood Avenue, South Yarra 3141, or telephone 650 8661 or 386 1599 (AH).

Notices

Cover Photograph Competition

Urgent — Send us your colour slides or prints

Entries for our competition to select 3 photographs for the front cover of *The Victorian Naturalist* have been very slow in coming in. Please help by sending your entries to The Editors at the office address as soon as possible. Note your name and address on the slides etc. for return. Remember, any topic or subject may be submitted.

FNCV Members Insurance Cover

All voluntary workers on the business of the FNCV, and all members whilst on club business and club excursions, are covered by the personal accident insurance policy taken out by the club. Details of the policy are held at the club office.

Australian Natural History Medallion

Mr Fred Rogers, noted botanist, educationalist, conservationist and photographer from Vectis, near Horsham, Victoria, has been awarded the prestigious Australian Natural History Medallion for 1991.

Mr Rogers personal contribution to the understanding of natural history in Australia, and in particular the state of Victoria, has been enormous. His knowledge of flora, his research, publications, photography and innumerable lectures have been invaluable to those interested in our native flora. His achievements include his books, *Field guide to Victorian Wattles* and *Plants of the Little Desert and Mt Arapiles* as well as his renowned garden at Vectis.

Of equal importance is the influence that Fred Rogers has had on a great many people, by encouraging them to become interested in natural history. He has involved himself in Field Naturalist Clubs, Societies for Growing Australian Plants and other groups. He has been extraordinarily dedicated and generous in sharing his information with vast numbers of people through his work with groups and individuals. Fred has been particularly involved in SGAP activities. For five years he was State President and was involved in the formation of the Federal body, as well as the establishment of both the Wimmera and the Maroondah Groups. Over the years he has led and organised many excursions, edited Nature Notes for school children and spent many years broadcasting on radio. More recently he has been advising people on shelterbelt plantings in the Wimmera.

The Australian Naturalist History Medallion, established in 1939 and administered by the Field Naturalist's Club of Victoria, is awarded each year to the person judged to have made the most meritorious contribution to the understanding of Australian natural history. Dr James H. Willis, medallionist of 1960, presented the 1991 ANHM at the FNCV's November meeting. Other previous medallionists include Vincent Noel Serventy (1974), Graham Pizzey (1986) and more recently, Bruce A. Fuhrer (1989) and Ellen M. McCulloch (1990). Fred Rogers is a very worthy winner and joins an illustrious group of medallionists.

Scott Watson



Fred Rogers (far right), Arthur Farnworth and Jim Willis at the presentation.

Vertebrate Fauna of Paddys Ranges State Park

C. R. Trainor*

Introduction

The main aim of this study was to compile an inventory, distribution and abundance of fauna species for Paddys Ranges State Park and Maryborough's forests. Paddys Ranges State Park is located 2 km south-west of Maryborough in central Victoria. This 1700 ha park was declared in 1989. It is distinctive box-ironbark open forest and the richness of the flora and avifauna in the park have been known to naturalists for many years (Maryborough Field Naturalist's Club 1972 and 1980). However, the fauna of the park, and the box-ironbark of the study area have been little studied.

Box-ironbark forests consist of monospecific or mixed stands of Long-leaf Box (*Eucalyptus goniocalyx*), Yellow Gum (*E. leucoxylon*), Red Stringybark (*E. macrorhyncha*), Yellow Box (*E. melliodora*), Grey Box (*E. microcarpa*), Red Box (*E. polyanthemos*) and Red Ironbark (*E. sideroxylon*) (Kellas 1991). The shrub layer is rich in species including a number of acacias such as Spreading Wattle (*Acacia genistifolia*) and Golden Wattle (*A. pycnantha*). *Cassinia*, *Grevillea* and *Pultenaea* species are common in this stratum.

These once extensive forests covered over 4,700,000 ha of Victoria (Newman 1961), but are now mainly confined to about 240,000 ha in north-central Victoria (Anon. 1984). Approximately 24,000 ha of box-ironbark forest is managed by the Maryborough Department of Conservation and Environment (DCE). Apart from Paddy's Ranges State Park the only other box-ironbark reserve in the Maryborough region is the Maryborough Regional Park (270 ha).

Box-ironbark forests have had a long history of timber utilisation and were essentially clear-felled during the goldrush

days of the 1860's, to provide fuel and mine shaft supports. Areas not worked agriculturally was replaced by coppice regrowth. Box and ironbark timbers are strong, durable, and dense and are used for heavy construction, fencing and fuel. Harvesting on a short rotation relies on coppice regeneration and has kept the forest more densely stocked as even aged, immature open forest with few tree hollows (LCC 1978).

The effects of habitat changes through agricultural clearance, grazing by introduced animals and timber harvesting are assumed to have decreased populations of many fauna species in box-ironbark forest. (Menkhorst and Gilmore 1979). The extent of population changes is not known as little documentation exists and virgin box-ironbark forests no longer exist for comparative studies.

Paddys Ranges State Park consists of sloping rocky ridges through the centre of the park, rising to 80 m above the surrounding flats. Mean daily temperatures reach a maximum in February (28°C) and a minimum in July (14°C). Mean annual rainfall is 500 mm. Soils are poor, sandy to clay-loams developed on Ordovician or Silurian slates and sandstones. The park was burnt by an intense wildfire in 1985. Forests north of Maryborough, such as Timor State Forest, were not burnt.

Methods

Six individual study sites were sampled (Fig. 1). All sites were sampled by Elliot traps and observation. Sites 1, 2 and 3 were sampled by artificial nestboxes, spotlighting and quadrat sampling techniques. Site 3 was located in Timor State Forest.

Elliot trapping was carried out monthly on a 20 m grid, covering a hectare. Harp traps for bat capture were set at two dams and a creek at site 1. Captured small

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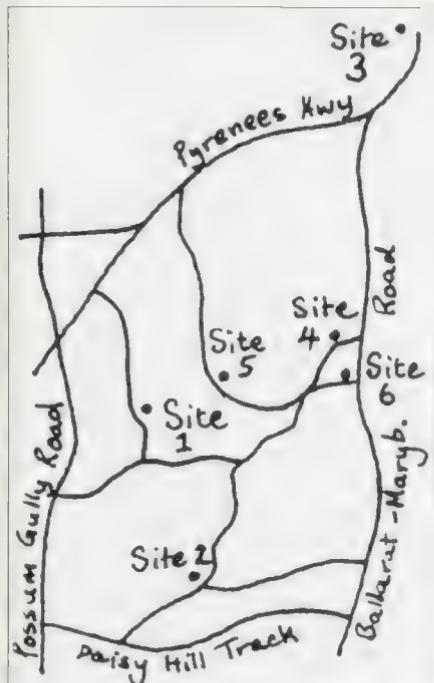


Fig. 1. Paddys Ranges State Park and study area. (More detailed map available from the Department of Conservation and Environment.)

mammals were weighed, sexed, then released. Terrestrial small mammals were also ear-tagged. Sixty nest boxes were used to survey hollow-using fauna. These comprised 52 log and eight ammunition boxes adapted as nest boxes (after Calder *et al.* 1983; Menkhorst 1984). Spotlighting was conducted over six nights (12 hours). Incidental observations of vertebrates such as scats and diggings were recorded. Hand searching for reptiles and amphibians involved overturning ground and tree debris.

Previous fauna surveys in the region have been carried out by Cheers (1990 a&b), Maryborough DCE (unpub.), Menkhorst and Gilmore (1979) and Seare (1989). Vertebrate nomenclature follows the Atlas of Victorian Wildlife (unpub.).

Results and Discussion

Vegetation Description

Four vegetation communities were identified within both Paddys Ranges State Park and Timor State Forest. The vegetation of the park is generally uniform open forest. Trees reach 12 to 20 m in height with small crowns. Trees are up to 70 years old and hollows are absent. *Eucalyptus sideroxylon* dominates the eastern sections of the park such as site 2. A dense cover of shrubs such as *Acacia genistifolia* and *A. pycnantha* is present along drainage lines and flat areas in the burnt park. Ground cover is variable consisting of Bitter-pea (*Daviesia leptopylla*), *Grevillea alpina* and Grey Everlasting (*Helichrysum obcordatum*). At site 3 the shrub layer of acacias is sparse, with coppice stump hollows present.

E. leucoxylon/E. microcarpa open forest occurs on the alluvial flats and in gullies as at site 1. A few stump hollows are present in this open forest. The shrub layer is dense with Eutaxia (*Eutaxia microphylla*), *Pultenaea prostrata* and *Acacia* spp. *E. goniocalyx/E. microcarpa* open forest occurs in patches. Understory species include *Acacia* spp., *G. alpina* and *P. prostrata*. Red Gum (*Eucalyptus camaldulensis*) open forest occurs in the west of the park along Timor Creek.

Fauna

The fauna of box-ironbark forests in the Maryborough region has not been surveyed systematically in the past. Through this survey, literature records and communications with naturalists, a total of 30 mammals, 103 birds, three amphibians and 16 reptiles have been recorded in the region. Totals for Paddys Ranges State Park are 19, 103, three and eight species respectively (refer to lists now held by FNCV).

Mammals

Twenty-one mammals were recorded during this survey of which six species were exotic. An additional nine species were

recorded by other data sources. Six species have been observed by local naturalists. The Platypus (*Ornithorynchus anatinus*) has often been observed in Tullaroop Creek (R. Chandler pers. comm.). Also recorded in Bet Bet Creek and Macallum Creek, their presence is often discovered by DCE staff investigating illegal fishing activities. A single historic report of the Feathertail Glider (*Acrobates pygmaeus*) comes from the north of the Paddys Ranges State Park in the 1940's (R. Bishop pers. comm.). Two Eastern Pygmy-possums (*Cercartetus nanus*) were found south of Maryborough in Burnt box-ironbark forest (R. Brouwers, pers. comm.). *A. pygmaeus* readily use nest boxes in the wetter forests of central Victoria (Calder *et al.* 1983; Orchard 1987), but have not been recorded in the drier forests of the study area using this technique in a total of approximately 1800 nest box inspections (Maryborough DCE unpub.; Sears 1989, this study). Feral Cats (*Felis catus*), have been seen in Paddys Ranges State Park (R. Brouwers pers. comm.). Fat-tailed Dunnarts (*Sminthopsis trassicaudata*), have been reported by local farmers (J. Bryant, pers. comm.). The Koala (*Phascolarotus cinereus*), has been observed one km south of the park. Results of this survey are consistent with the data collected by Menkhorst and Gilmore (1979) who found that the central Victorian forests supported low densities of both ground dwelling and arboreal mammals. High species richness but low numbers within each species was found to be a characteristic of dry sclerophyll forest by Chesterfield *et al.* (1988). Short-beaked Echidnas (*Tachyglossus aculeatus*) were not observed, but evidence of their presence such as diggings and scats were recorded. Two species of small mammal, the House Mouse (*Mus musculus*), and the Yellow-footed Antechinus (*Antechinus flavipes*), were captured in Elliot traps. Trapping was unsuccessful at sites 2 (380 trap nights), 4, 5 and 6 (60 trap nights each). Twenty-six mammals were caught in a total of 1280 trap days and 220 trap days (Table 1).

Table 1. Elliot trap captures and trap effort.

	Site 1	Site 3	
	am	pm	
<i>M. musculus</i>	6	-	-
<i>A. flavipes</i>	-	18	2
Trap periods	380	340	220
Trap rate	1.5%	5.9%	0.9%

Mus musculus was recorded from only one of the five sites in the burnt park. Studies have found *M. musculus* to be an early fire colonist (Newsome 1983). Fifteen Black Rats (*Rattus rattus*) were observed by spotlight in a mineshaft used as a tip near the southern park boundary. This tip was bulldozed by DCE.

A Water-rat (*Hydromys chrysogaster*) was observed in the lake at Phillips Gardens (urban Maryborough). Local shopkeepers also reported *H. chrysogaster* on their premises while the lake was drained in 1991.

At the unburnt site 3, a relatively high Elliot trap capture rate and nest box use (including breeding in two boxes), was recorded for *A. flavipes*. Christensen and Kimber (1975) have found *A. flavipes* to be detrimentally affected by fire in Western Australia. Habitat at site 3 had little ground cover but had a number of small coppice stump hollows which are important shelters for *A. flavipes* (Lindner 1983). Stump hollows are readily destroyed during wildfires and fuel reduction burns. The overall small mammal trap rate of 1.9% was much lower than the mean trapping rate of 12.6% achieved by the Mammal Survey Group of Victoria throughout Victoria (Wilson 1990).

The most notable mammal recorded in this survey, the Brush-tailed Phascogale (*Phascogale topoatafa*), is also the only listed species on the Flora and Fauna Guarantee List (Flora and Fauna Support Group 1991). A single animal was recorded using a nest box at site 2 in March 1991. Calder *et al.* (1983) and Orchard (1987) also recorded *P. topoatafa*

in nest boxes early in the year, and attributed this to young animals dispersing. A total of 11 bats, from three species representing one family, the Vespertilionidae, were captured in 18 trap nights (Table 2).

Table 2. Bat trap captures and trap effort.

	Reserve	Kirk		
	Dam	Dam	Site 1	Total
<i>C.morio</i>	-	1	4	5
<i>E.vulturnus</i>	-	-	4	4
<i>N.geoffroyi</i>	-	-	2	2
Trap nights	5	4	9	18
Trap rate	-	0.2%	1.2%	0.6%

At sites 1 and 2 female Lesser Long-eared Bats (*Nycophilus geoffroyi*) were recorded using nest boxes in spring. Between eight and 20 *N. geoffroyi* were observed; some carrying twin young. A single Gould's Wattled Bat (*Chalinolobus gouldii*) was recorded using a nest box at site 2 in April 1991. The Chocolate Wattled Bat (*Chalinolobus morio*) has been recorded using nest boxes in the area by Seare (1989). A Little Mastiff-bat (*Mormopterus planiceps*) was captured in a bungalow at Welshmans Reef, 25 km east of Maryborough.

Trapping recorded the small Vespertilionids which generally dominate trapping results. The low trap success is typical of dry open forests, which has been attributed to the openness of vegetation lessening the probability of capture (Brown and Howley 1989). Other bat species recorded for the area include the Grey-headed Flying Fox (*Pteropus poliocephalus*), Western Broad-nosed Bat (*Scotorepens balstoni*), and the Little Broad-nosed Bat (*S. greyii*) (Atlas of Victorian Wildlife unpub., Menkhorst and Gilmour 1979).

Sugar Gliders (*Petaurus breviceps*), were recorded using nest boxes at each site. They used boxes throughout the year as a diurnal shelter and for breeding during late winter and spring. Usually between one

and six gliders were recorded each inspection. *Petaurus breviceps* is believed to be adapted to maximum post-fire *Acacia* regrowth, (Braithwaite *et al.* 1983), the sap of which is a preferred food source. The territorial nature and the use of small home ranges of 0.5 to 1.5 ha (Suckling 1984), would limit nest box use to a single family of *P. breviceps*. Common Brushtail Possums (*Trichosurus vulpecula*) used nest boxes infrequently at site 1. A *T. vulpecula* was also spotlit and observed in a natural hollow at site 1 (possibly the same animal). Common Ringtail Possums (*Pseudochirus peregrinus*) was not directly observed but a bark strip nest constructed in a nest box is attributed to *P. peregrinus*. The scarcity of this species may in part be explained by the lack of a tall, dense shrub layer which is its preferred habitat (McKay 1983).

The relative abundance of arboreal mammals found during this study, using spotlight searches on foot, was low (0.1 Observations per Spotlight Hour (OSH)), compared to results obtained in north-eastern Victoria (2.0 OSH, Bennett *et al.* 1991), and in central and northern Victoria (0.9 OSH, Menkhorst *et al.* 1988). The low rate of observation may to some extent be a result of limited sampling and also the density of epicormic fire regrowth. The lack of tree hollows through intensive timber harvesting is likely to be the main factor limiting population sizes of hollow-using arboreals, although both *P. breviceps* and *T. vulpecula* are known to be adaptable in their use individual shelters (Calaby 1966). The distribution of arboreal marsupials may also be limited by foliage nutrient concentrations (Braithwaite *et al.* 1984).

The Rabbit (*Oryctolagus cuniculus*), Eastern Grey Kangaroo (*Macropus giganteus*) and Swamp Wallaby (*Wallabia bicolor*) were ubiquitous, with diurnal and nocturnal observations and evidence such as scats and spoor recorded. *Wallabia bicolor* and *M. giganteus* were abundant in the park and the study area. *Wallabia*

bicolor is known to prefer dense vegetation (Merchant 1983) and to be more abundant in dense post-fire regrowth (Heislers 1974).

Three Brown Hares (*Lepus capensis*) and four dogs (*Canis familiaris*) were observed during the day in the park. Only three Foxes (*Vulpes vulpes*), were observed, but a local poultry farmer shot 49 in a six month period near the eastern boundary of the park, (B. Stewart pers. comm.), providing a more accurate indication of their abundance.

Birds

The Maryborough area is an important area for birds in central Victoria with a total of 247 species recorded (Cheers 1990a). 103 species (41% of total), have been recorded in Paddys Ranges State Park (refer to list held by FNCV), primarily in the years since the 1985 fire.

Some birds commonly observed were the Common Bronzewing (*Phaps chalcoptera*), Eastern Rosella (*Platycercus eximius*), Willie Wagtail (*Rhipidura leucophrys*), Grey Shrike-thrush (*Collurincincia harmonica*), White-browed Babbler (*Pomatostomas superciliosus*), Yellow-tufted Honeyeater (*Lichenostomus melanops*), Red Wattlebird (*Anthochaera carunculata*) and White-winged Chough (*Corcorax melanorhamphus*).

The Australian Owlet-nightjar (*Aegotheles cristatus*), Eastern Rosella and Red-rumped Parrot (*Psephotus haematonotus*), were recorded using nest boxes. The Australian Owlet-nightjar used boxes at each site, year round for diurnal shelter and bred in boxes at sites 1 and 2. Eastern Rosellas and Red-rumped Parrots used boxes only for breeding, laying between four and six eggs in spring, but none hatched.

As the vegetation progresses through post-fire and logging successional stages it is likely that a number of bird species will be added to the list for the park. Of the 40 species of birds listed as threatened in Victoria by Baker-Gabb (1990), only the Swift Parrot (*Lathamus discolor*) has been

recorded in Paddys Ranges State Park. Nineteen (18%) of the species listed for the park require tree hollows for breeding. A number of hollow-using birds such as owls and cockatoos are known to breed only in areas with mature trees, found, in this region, along creeks.

Amphibians and reptiles

A total of three amphibians (Families Hylidae and Myobatrachidae) and eight reptile species (Families Agamidae, Gekkonidae, Scincidae and Varanidae) were recorded in the study area. An additional nine species were recorded in the study area by other data sources (refer to species lists held by FNCV). Roadkill victims of the Common Long-necked Tortoise (*Chelodina longicollis*) have been observed by local naturalists near Phillips Gardens (R. Bishop pers. comm.), and Goldfields Reservoir (J. Trainor pers. comm.). *Chelodina longicollis* is likely to be common in farm dams and waterways in the region.

The Eastern Brown Snake (*Pseudonaja textilis*) has been observed in Paddys Ranges State Park, and the Common Scaly-foot (*Pygopus lepidopodus*), has been recorded in the city of Maryborough (R. Brouwers pers. comm.).

The Spotted Marsh Frog (*Limnodynastes tasmaniensis*) and Southern Brown Tree Frog (*Litoria ewingii*) were abundant under ground debris at several dams in the park. A Southern Bullfrog (*Limnodynastes dumerili*), was captured at a small tip in the park.

The reptiles recorded were observed throughout the vegetation communities of the park. The most common species were the Garden Skink (*Lampropholis guichenoti*) Large Striped Skink (*Ctenotus robustus*) and the Tree Dragon (*Amphibolurus muricatus*). The skinks were most often observed in the litter layer, while *A. muricatus* was observed on forestry tracks.

The Eastern Bearded Dragon (*Pogona barbatus*), Marbled Gecko (*Phyllodactylus*



Fig. 2. The capture of a Sand Goanna in the Maryborough Regional Park is one of the most south-eastern records of this species in Victoria.

marmoratus) and Sand Goanna (*Varanus gouldii*) were uncommon. A single *V. gouldii* (Fig. 2) was captured by hand in the Maryborough Regional Park, one km north of Paddys Ranges State Park.

Pogona barbatus, Olive Legless Lizard (*Delma inornata*), *P. lepidopodus*, Thick-tailed Gecko (*Underwoodisaurus milii*) and *V. gouldii* occur more commonly in northern (Eyrean) Victoria (Atlas of Victorian Wildlife, unpub.). These species have rarely been recorded in the study area. The Striped Legless Lizard (*Delma impar*) is the only species recorded for the area listed on the Flora and Fauna Guarantee List (Flora and Fauna Support Group 1991).

Numerous rubbish dumps containing sheets of tin provide valuable herpetofauna habitat in the study area (where little ground debris is available for shelter sites).

Conclusion and recommendations

Prior to its creation Paddys Ranges State Park was managed for intensive timber harvesting like the remainder of Maryborough's box-ironbark forests. Immature forest communities with few tree hollows have been cultivated.

This survey found that the park retains a fauna rich in species with low densities of a number of species, particularly those requiring large tree hollows. As Bennett (1990) notes fragmentation of wildlife habitat can also occur in large intact tracts of vegetation. As the park progresses through post logging and wildfire successional stages and produces mature forest (in 50 to 200 years), the richness and particularly the diversity of species dependant on mature forest is likely to strongly contrast with the surrounding State Forest.

A reserve system of continuous habitat corridors through the remaining State

Forest blocks is recommended. Linear reserves of 5 to 10 percent in area of each of the blocks would be necessary. This type of reserve system would alienate the least area from timber harvesting, while eventually providing habitat for species requiring mature forest.

The extensive use of artificial nest boxes in the Maryborough area should be encouraged and co-ordinated by the DCE and local interest groups. Future fauna surveys in the region should concentrate on quantifying species distributions, abundance and responses to management (eg. mining and timber harvesting). Reptiles and bats are particularly poorly known in the region.

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Fauna was handled under the provision of research permits issued by the DCE.

Species lists for the fauna of Paddys Ranges State Park are available from the FNCV.

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Terrestrial Flatworms

Leigh Winsor*

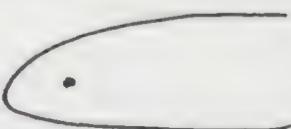
Terrestrial flatworms (also called land planarians) are entirely free-living carnivorous flatworms which belong to the same animal Phylum (Platyhelminthes) as parasitic flukes and tapeworms. Two families of land planarians are represented in Australia. Species with two eyes belong to the Rhynchodemidae, those with multiple eyes to the Geoplanidae. The Bipaliidae have an expanded fore-end and are represented here by a sole exotic (introduced) species.

These worms range in size from 5 to 100 mm in length, and 1-10 mm, in width. They are generally flattened, elongate and tapered at either end. Some species are brightly coloured with dark longitudinal or transverse bands and stripes. Others exhibit camouflage patterns and colours. Mucus is secreted from the skin and the worms are sticky to touch. Planarians move on a creeping sole with a gliding motion, but when disturbed can crawl rapidly with a strong muscular action which is why people commonly mistake flatworms for leeches.

The terrestrial flatworms have few means to prevent drying out. Hot and dry conditions are fatal to them. Consequently they are nocturnal and frequent dark humid microhabitats under fallen rotting timber, stones and litter on the forest floor. After prolonged periods of rain or at times when the weather is cool and overcast, flatworms are active during the day - it is then they are often found and taken to a museum for identification.

Earthworms, small insects, slaters, snails and slugs (all members of the ecological group to which the flatworms belong - the cryptozoa) are the main food sources for the planarians. Some species of flatworms are cannibalistic. Others are scavengers and may feed upon dead insects, earthworms or small vertebrates such as frogs or lizards.

Rhynchodemidae



Geoplanidae



Bipaliidae



Indication of size



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Contributions

Most flatworms have primitive eyes which are sensitive to light and dark. Prey is located by chemical receptors situated in minute pits around the fore-end of the worm.

Secretions of flatworms are very sticky, injurious to prey, and repugnant and toxic to predators. Prey is captured by being rapidly overlain then immobilized with sticky mucus. Elongate species may loop their body over the victim, and some species capture small insects using an adhesive sucker situated on the fore-end. The prey is manipulated to the mouth, situated in the mid-belly region, through which the pharynx is protruded to penetrate the victim.

The pharynx is a highly muscular cylindrical or ruffled collar-shaped organ equipped with powerful enzymes that help to dissolve the prey. Partially digested particles of prey together with mucus are transferred into the intestine by the sweeping action of fine hair-like structures (cilia) which line the pharynx.

Within the cryptozoa, flatworms are at the top of the food chain and have few enemies. They do however succumb to bacterial, fungal and protozoal infections, and to the larvae of fungus-flies (*Planivora*). The greatest threat to terrestrial flatworms is destruction of their habitat by human activities; urban expansion, commercial forestry practices such as clear felling and silviculture, and by frequent fuel-reduction burning of forests.

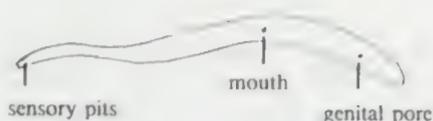
Terrestrial flatworms are hermaphrodites, that is having both male and female reproductive organs. Normally they reproduce sexually by cross-fertilization with another of their species. Embryos are protected within a tough-skinned cocoon laid by the worm during autumn and spring in a humid, protected site, for example cemented beneath a log. There may be 1-15 young in each cocoon which hatch after 8-9 days. The juveniles take about six to nine months to mature.

Asexual reproduction by fission

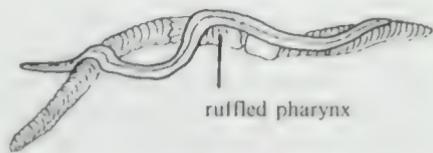
upper surface



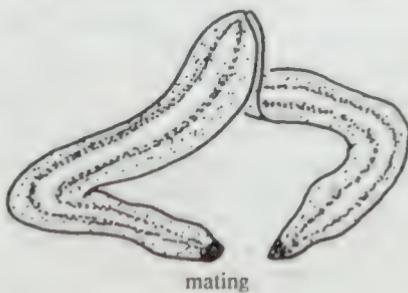
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Land planarian capturing an isopod using the sucker at the fore-end



Land planarian feeding upon an earthworm



Contributions

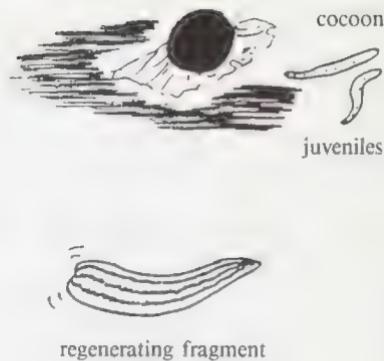
(fragmentation or architomy) is often observed in some thin elongate species living under less than optimal conditions (for example, rainforest species inadvertently carried with rooted plants to live in a hothouse). The process normally occurs 24-48 hours after the flatworm has fed. It begins with a constriction 1-2 centimetres from the hindmost end of the body. Eventually the hind portion of the worm is caught on some obstruction, detaches and then crawls away. Over the next 1-2 weeks the shed fragment fully regenerates to form a new worm which can then feed and eventually either breed sexually if conditions are right, or continue reproducing by fission. Flatworms live for about a year.

Land planarians are found in a variety of habitats ranging from tropical rainforest to arid semi-desert. Some species have been inadvertently introduced together with soil surrounding plants from their native habitat into urban gardens. Here they are often seen under flower-pots, black garden plastic or around the pet's feeding dish.

Scientists are interested in flatworms. Planarians are the simplest animal to possess a true brain and have been found to have a simple form of memory. They are renowned for their ability to withstand experimental starvation, and for their regenerative powers following subdivision.

Some terrestrial flatworms are of economic and medical importance. One species (*Platydemus manokwari*) is used to biologically control the Giant African snail, a serious pest in the Pacific region. Some species of flatworm in Hawaii and in New Caledonia are intermediate hosts for the Rat Lung worm, the cause of one form of encephalitis in humans.

World wide there are over 500 described species of terrestrial flatworms, and many more species are yet to be described. Land planarians are more numerous and diverse in the tropics and temperate southern hemisphere than elsewhere. There is no fossil record of land planarians. However the flatworms are good indicators of past



geographical relationships as they tend to disperse slowly, being moisture dependent and having no resistant or specifically adapted dispersal stages. The composition of the flatworm fauna of northern Australia is similar to those of the Indo-Malay region, whilst the flatworms of southern Australia are most closely related to those of New Zealand. Land planarians, like their freshwater cousins, may prove useful indicator species for monitoring changes to the environment.

Identification of flatworms is made from external features such as shape, colour, markings and eye pattern, combined with internal anatomical features such as musculature and copulatory organs revealed by microscopic examination.

First Record of the Eastern Grey Kangaroo, *Macropus giganteus*, at Hattah-Kulkyne National Park, North-western Victoria

Graeme Coulson* and Sally Troy**

In Victoria, the Eastern Grey Kangaroo, *Macropus giganteus*, and the Western Grey Kangaroo, *Macropus fuliginosus*, occur in a band of sympatry which arcs from southwest Victoria through Central Victoria to the north-west of the state (Coulson and Hutchinson 1983; Caughley *et al.* 1984). This band is narrow in the south-west and central Victoria but becomes wider in the north-west where it continues into N.S.W. There, the overlap between the two species is more extensive and both occur throughout much of the western half of the state (Caughley *et al.* 1984).

Hattah-Kulkyne National Park, in north-western Victoria, lies on the border of the two states. The Western Grey Kangaroo has long been known to occur in the park, together with a small population of Red Kangaroos, *M. rufus* (Coulson 1988). A culling program has been undertaken in an experimental area of the park to encourage regeneration of plant communities that have been threatened by the heavy grazing pressure exerted by the kangaroos (Department of Conservation and Environment, undated). The park now carries a population of 26,000 Western Grey Kangaroos (Morgan 1991).

Although Caughley *et al.* (1984) reported the occurrence of both Eastern and Western Grey Kangaroos on the New South Wales side of the Murray River between Mildura and Hattah-Kulkyne National Park, there have been no reliable records of the former species in the park. This note reports the first unequivocal sighting of the Eastern Grey Kangaroo in Hattah-Kulkyne National Park.

During a reconnaissance of the park on

23 June 1991, the authors observed two Eastern Grey Kangaroos in the vicinity of Lake Bitterang (34°40'S, 142°22'E), roughly in the centre of the park. They were observed between 1230 and 1300 hours in good light conditions. The first individual, an adult male, was sighted from a distance of about 250 m in grassland 1 km north of Lake Bitterang. He was observed briefly with 7x50 binoculars and a 22x spotting scope before he fled with a group of eight Western Grey Kangaroos into Black Box, *Eucalyptus largiflorans*, woodland to the north. The second individual was sighted shortly after the first in grassland adjacent to Red Gum, *Eucalyptus camaldulensis*, woodland, some 500 m north of the lake. This individual was smaller, but its sex could not be determined. It was viewed with binoculars and telescope from less than 100 m for about 5 minutes as it stayed some 20 m from a group of Kangaroos. It then hopped towards, but did not join, another group of Western Grey Kangaroos near the woodland.

Our attention was initially drawn to the two Eastern Grey Kangaroos by the overall caramel coloration of their pelage, which was noticeably paler than the typical chocolate-brown of the Western Grey Kangaroos in the area. The diagnosis was confirmed by the characteristic pale face of the Eastern Grey Kangaroo, as described and illustrated by Kirsch and Poole (1972) and Caughley *et al.* (1984).

The occurrence of Eastern Grey Kangaroos at this site is noteworthy because they were observed near a transect line where one of us (GC) had made thousands of sightings of only Western Grey Kangaroos while conducting population and movement studies between 1983 and 1986 (Coulson and Norbury 1988). Further surveys will be needed to

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determine whether the sightings reported here represent no more than a couple of transient individuals, or whether there is now a resident population of Eastern Grey Kangaroos in Hattah-Kulkyne National Park. The possibility of a third species in the park should be considered in future monitoring and management of the kangaroo populations.



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Notes from the National Herbarium of Victoria No. 11 Authorities in Plant Nomenclature

Ian Clarke*

This is the third in a small series of articles dealing with aspects of botanical nomenclature that began in The Victorian Naturalist, vol. 108, no. 5. An understanding of the contents of the previous articles has been assumed.

In botanical texts and in papers published in journals, the scientific names of plants are often followed by the (abbreviated) names of the botanists responsible for coining them. These abbreviated names are called authorities.

In the following examples, the authorities given are those for the names of species, i.e., the authors concerned coined the specific epithets and used each in conjunction with a particular genus.

This type of authority is the most commonly encountered, however, botanical names at all ranks, once formally published, have authorities. Numbers 1, 3 and 4 are taken from the journal *Muelleria* 7, no. 2, published by the National Herbarium of Victoria.

1. *Pomaderris oblongifolia* N. G. Walsh 'N. G. Walsh' is the authority for the combination *Pomaderris oblongifolia*, i.e., N. G. Walsh decided on the epithet *oblongifolia*, and used it when naming this new species of *Pomaderris*.

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Contributions

2. *Narcissus pseudonarcissus* L.

'L.' is the authority for the name *Narcissus pseudonarcissus* (daffodil); this is the accepted abbreviation for Linnaeus, the author of the name.

3. *Callistemon pungens* P. F. Lumley & R. D. Spencer

The authority for the name *Callistemon pungens* is 'P. F. Lumley & R. D. Spencer', i.e., they are the authors of the name.

4. *Haegiela tatei* (F. Muell.) P. S. Short & P. G. Wilson

The authority for the name *Haegiela tatei* is '(F. Muell.) P. S. Short & P. G. Wilson'. F. Mueller was the author of the name *Epaltes tatei*. Short and Wilson believed Mueller's species was incorrectly placed in *Epaltes* and transferred it to the genus *Hagiela*, and are therefore the authors of the new combination of generic name (*Hagiela*) and specific epithet (*tatei*). Mueller's name is retained within the authority in parentheses indicating that he first used the specific epithet in naming this species.

The authority is essentially an abbreviated bibliographical reference. It is not part of the name, but aids nomenclatural precision and helps to avoid confusion. For example, the genus *Banksia* L.f. is accepted and recognised whereas the genus *Banksia* Forster & G. Forster has been rejected. They are totally different things—the Forsters' version of *Banksia* is now known as a species of riceflower in the genus *Pimelea*. The use of the authority identifies which *Banksia* is intended.

The following are some examples of authorities commonly seen with Australian plant names.

A.DC. - Alphonse de Candolle (1806-1893), son of Augustine (below).

Benth. - George Bentham (1800-84), English author of the first flora of Australia.

Cunn. - Allan Cunningham (1791-1839), British plant collector in Australia.

DC. - Augustine Pyramus de Candolle (1778-1841), Swiss botanist.

F. Muell. - Ferdinand Mueller (1825-1896), German born, came to Australia in 1847, and was the first Victorian Government Botanist from 1853.

Labill. - Jacques Julien Houtton de Labillardiere (1755-1834), French botanist and explorer.

L. - Carolus Linnaeus (1707-78), Swedish botanist. Also known as Carl von Linne.

L. f. - Carl von Linne (1741-83), son of the above.

R. Br. - Robert Brown (1773-1858), British botanist.

The construction of authorities, and the abbreviations and punctuation used within them are quite specific. Parentheses, for example, have a particular meaning and should not be used indiscriminately. The abbreviations for the authors' names themselves usually follow a standard such as those found in the, 'Draft Index of Author Abbreviations' published by the Royal Botanic Gardens, Kew, England (1980).

The following list includes the signs and abbreviations most often encountered plus a few other terms that are not strictly part of the authority. An understanding of their meaning, and some familiarity with the names of the botanists who have worked with naming our flora, allows an appreciation of the historical interest inherent in plant names.

() enclose the first of two authors' names, indicating that the first author originally used the specific epithet for the same species but in a different genus or a different rank. (e.g. 7, 10)

& = et = and. Connects two joint authors.

et = and. Connects two joint authors.

et al. (latin) = and (of) others.

ex connects the names of two authors - the second author published the species name acknowledging that it was proposed (but not published)

Contributions

by the first author. Sometimes an authority of this type is abbreviated by omitting the first author's name. (e.g.s. 6, 7, 8)

f. = filius (latin) = son (of). (e.g. 10) connects the names of two authors - the first author published the species name in a larger work written or edited by the second author. Sometimes an authority of this type is abbreviated by omitting the second author's name. (e.g.s. 5, 6, 9)

ined. = ineditus (latin) = unpublished.

ms. = manuscript. Used following a name or authority indicating that the name as yet appears only in a manuscript form, i.e., unpublished.

sensu (latin) = in the sense of. (e.g. 9).

sp. aff. = species affinis (latin) = species akin to. Used to indicate that a plant is closely allied to, but not exactly referable to, the named species. (e.g. 9).

Examples: (The abbreviated reference following each authority refers to the journal or book in which the name was first published.)

5. *Acacia aspera* Lindley in Mitch., Three Exped. Int. East Austral. 2: 138 (1838). Lindley is the botanist responsible for publishing the name in Mitchell's journal.
6. *Acacia calamifolia* Sweet ex Lindley in Edwards's, Bot. Reg. 10: t. 839 (1824). Lindley is the botanist responsible for publishing the name (but attributed it to Sweet) in Edwards's Botanical Register.
7. *Acacia deanei* ssp. *paucijuga* (F. Muell.

ex Wakef.) Tind., Contr. NSW Natl Herb. 4: 56 (1966).

Wakefield first published the subspecific epithet 'paucijuga' at the species level and acknowledged Mueller as the source of the name. Subsequently Tindale reduced Wakefield's species to a subspecies of *A. deanei*. The parentheses in this case record the change of rank of the epithet.

8. *Acacia pravissima* F. Muell. ex Benth., Linnaea 26: 608 (1855).

Bentham published the name (acknowledging it as Mueller's) in the journal Linnaea.

9. *Acacia* sp. aff. *pendula* sensu Court in J. H. Willis 2: 237 (1973) = *A. melvillei*.

The botanist, Court, writing in Willis's Handbook refers to a species as *Acacia* sp. aff. *pendula*, i.e., a species of *Acacia* closely akin to *A. pendula*. In this sense (i.e., as Court used the name) it is replaced by the name *A. melvillei*.

10. *Baeckea virgata* (Forst. & Forst. f.) Andr., Bot. Repos. 10: t. 598 (1810). J. R. Forster (the elder) and G. Forster (the son) first named this species *Leptospermum virgatum*. Andrews subsequently transferred the species to the genus *Baeckea*, retaining the same epithet. The parentheses in this case record the change of genus.

Further reading:

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Effects of Slashing and Burning on Orchids in French Island State Park

Clive and Fay Gordes

This is the second of a series of observations by Clive and Fay Gordes of responses of orchids to management on French Island. The first Naturalist Note was published in Volume 108(6), 1991.

Corybas fordhamii

Two colonies of *Corybas fordhamii* (Banded Helmet Orchid) have been discovered in the Park. The smallest group is found on a slash line through a small seasonally inundated sedge swamp. The line was slashed in early 1987 and in that year 30 leaves and 5 flowers grew to maturity. The *Corybas* species only produce one leaf per plant. Almost every leaf produced a flower but most flowers were cut off at leaf level by a bug which was never located. The line has not been slashed since and the numbers have steadily declined, until over the last two years only two or three leaves and one flower have appeared.

The second colony was located in burnt wet heathland. The site was burnt in September 1986. Hundreds of leaves appeared and each leaf had a flower. Most of the flowers reached maturity and set seed. In the second year there were leaves aplenty but we were only able to locate ten flowers. The third year produced few leaves and three flowers. By the fourth year we were not able to locate any flowers and could find only a few leaves.

Thelymitra benthamiana

In 1987 we found a small colony (three plants) of *Thelymitra benthamiana* (Blotched Sun Orchid) on a firebreak that is slashed annually. In November 1988 we noted eight flowering plants in the same area. By 1989 the numbers had doubled to sixteen, and in 1990 almost doubled again with twenty seven plants. Numbers stabilised in 1991 at twenty seven plants.

Department of Conservation and Environment slash the firebreaks in and around the park once a year, generally in January, however in 1990 this firebreak was slashed on December 16th. We have

monitored the seed set of this species and most pods do not harden off until the end of December so this may account for the stabilisation of numbers in 1991. DCE did not slash in 1992 until January when all plants have set seed. The unslashed heathland on either side of the firebreak has been thoroughly searched and no *Thelymitra benthamiana* have been found.

Genoplesium pumilum

Generally on French Island in unburnt vegetation *Genoplesium pumilum* (Green Midge Orchid) is a solitary species, however at one site a small group are found growing together. We have observed that, usually, this orchid is a companion plant of *Hakea nodosa* on French Island. These isolated plants in unburnt vegetation rarely open during flowering. Of eight plants that are monitored each year only one has been found with open flowers, this plant has not reappeared since opening. In 1989 we discovered a group of 25 plants in an area burnt in November, 1987. The site was checked in 1988 but no plants of this species were noticed. Numbers declined to four plants in 1990 and in 1991 only one plant could be found. At another site six plants were found in burnt vegetation 18 months after a fire and in the following year seven plants came through. No plants have been located in this area since that time. Although no open flowers were observed in these burnt areas it appears many did open as flowers were not tightly closed and in some cases the labellum protruded from the closed flowers.

Prasophyllum parviflorum

We first found *Prasophyllum parviflorum* (Slender Leek Orchid) flowering on a slashed firebreak in October 1986. Twenty plants were counted in that year. In subsequent years numbers have

declined, 16 in 1987, 15 in 1988, 3 in 1989, 3 in 1990, until 1991 when no plants were observed. This section of firebreak was not slashed in 1990 whereas it had been slashed previously each year. The area adjacent to this firebreak was burnt in November 1987 and in October of the following year fourteen robust plants appeared in the burnt heathland. These plants from the burnt site were approximately twice the size of the plants growing alongside of them on the firebreak. In 1989 six plants flowered in the burnt area however no plants were found in 1990 or 1991. The firebreak was slashed in January 1992.

It is common knowledge among orchid enthusiasts that many orchid species appear in large numbers and flower profusely in the growing season after fire. Observations of three species *C. fordhamii*, *G. pumilum* and *P. parviflorum* have, in this study, shown this trend. Groups of plants discovered in the flowering season after a fire, have been monitored in subsequent years. In each case, there is a

general decline in both number of plants and in flowering with each year after the fire.

Slashing is often advocated as an alternative to fire. In terms of orchid management this needs to be researched in more depth. From the observations made, two interesting trends emerge. In one case, *T. benthamiana* increased from 3 plants to 27 plants over 4 years and then stabilised at that last count. Whereas in the case of *P. parviflorum* the numbers in a group of plants found on a regularly slashed firebreak declined over the period of monitoring.

The observations provided in this note are based on one or two colonies for each species. *If more orchid watchers monitored specific colonies over a number of years, the responses of orchid species to management practices could be pinpointed.

* This is a challenge that could be taken up profitably by ENCV members. Eds

Yarra Pigmy Perch (*Edelia obscura*) in the Fitzroy River, South Western Victoria

A. J. Donnelly* and C. J. Grieves**

On the 3 March 1988, we surveyed the fish of the Fitzroy River, Victoria, just south of the Princes Highway bridge (lat. 38°30'S, long. 142°E). The river had virtually no flow and stood in deep pools. It was fringed by willows which formed an almost unbroken canopy shading the bank. We observed abundant aquatic plant growth dominated by Milfoil (*Myriophyllum muelleri*) and Pondweed (*Potamogeton perfoliatus*).

Using a triangular dip net with a 1.5 mm mesh, three species of fish were captured. These were Common Galaxias or Jollytail (*Galaxias maculatus*), Southern Pigmy Perch (*Nanoperca australis*) and Yarra

Pigmy Perch (*Edelia obscura*). The first two species are among the most common native fish in southern Victoria but the Yarra Pigmy Perch is classified as rare or of restricted distribution by the Department of Conservation Forests and Lands (1987).

We believe that Yarra Pigmy Perch may not have been reported previously from the Fitzroy River, although it is known to be present in the Eumeralla River, about 10 kms to the east. In 1980 this species was known definitely only from two river systems in coastal Victoria, the Yarra and the Eumeralla (Llewellyn 1980), although it had been reported in some sites in South Australia including Piccaniny Ponds (Scott, Glover and Southcott 1974). It has now

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been reported at a number of other sites in both south-eastern S.A. and east of the Yarra in Victoria (Cadwallader and Backhouse 1983), but no further reports in western Victoria.

In addition to the three species of fish reported above, we also captured numerous shrimps (*Paratya australiensis*), Freshwater Crabs (*Amarinus lacustris*) and small clams (*Corbiculina sp.*). There was also abundant evidence of Water Rat (*Hydromys cysogaster*) activity in the form of discarded clam shells which littered the prominences on the bank.

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Where 2!

J. A. D. Blackburn*

In *The Victorian Naturalist* Vol. 107 (5/6) Oct/Dec 1990, the subject of locality description was briefly discussed under the title *Where?* and some guidelines were given. In the Research Reports section of the same issue two contrasting methods of references are used. In what we might, for brevity, call the *Whale* report, areas are referred to by quoting the latitude and longitude which can then be identified or plotted on the best available map. I could not find Orwell Rocks, (38, 03'S, 140 44'E) in my gazetteer but deduced from its quoted geographical position that is about 3 km east of Port MacDonnell (38 03'S, 140 42'E) in South Australia. Similarly a small scale map of Western Australia indicated that the location referred to was just north of Fremantle, and Warton Street was found in the Perth street directory in the suburb of Mosman Park. Hence references using latitude and longitude provide accurate pinpoints of locality on all map types, and are thus, of most use generally.

In the *Frog Report* the Australian Map Grid reference is used in the form: AMG 8623 415717. This pinpoints the location to the nearest 100 metres as scaled from map number 8623 in the National Topographic series, 1:100000 scale (1 cm to

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1 km). In this instance the 415 indicates that it is 641500 metres east and the 717 places it 5871700 metres north of the grid false origin. The six-figure grid reference sequence is repeated at 100 km intervals hence the map number is essential. This method of referring to places on the map is ideal for field work. However in the final report it is useless to the reader unless he has a copy on hand of the same editions of all of the maps covering the area under review. In most instances this would not be so.

The author of the report had the solution readily available as the 1:100000 map series has collimation ticks to mark each minute of latitude and longitude along the boundaries and at 10 minute intervals within the sheet. Alternatively the rectangular coordinates may be converted to geographics by the appropriate mathematical formulae, and in these circumstances a high degree of accuracy is not warranted.

Despite its demonstrated inferiority the grid reference system is still widely employed in scientific reports for locality identification. It should be reserved for use in field work and, if published, appear only as a supplement and not to replace the universal system of latitude and longitude.

Historical Records of Australian Bustards (*Ardeotis australis*) in Eastern Victoria

Ian Lunt*

The Australian Bustard (*Ardeotis australis*) is a large, ground-dwelling bird that occurs in grasslands and open scrublands and woodlands in all mainland states of Australia (Pizzey 1980; Blakers *et al.* 1984). It is now threatened with extinction in south-eastern Australia, owing to the ubiquitous modification of native grasslands and grassy woodlands for agriculture. It is listed as an endangered species in Victoria (Baker-Gabb 1990), and as being vulnerable to extinction in New South Wales and South Australia (Robinson and Brouwer 1989). Its present rarity has been attributed to shooting, poisoning, habitat alteration, disturbance during nesting, and the impact of grazing animals (sheep and cattle) and predators such as foxes (Emison *et al.* 1987).

In the 'Atlas of Victorian Birds', Emison *et al.* (1987, p. 97) note that, 'At the time of European colonization, Australian Bustards were widespread in grasslands and some lightly wooded areas of western Victoria! They do not record the species from eastern Victoria. Recently, while researching the original vegetation of central Gippsland, I came across a number of references to 'wild turkeys', as Bustards are widely known. These records are presented below.

Gippsland records

The earliest record of Australian Bustards in Gippsland is from Matthew Macalister, who accompanied Angus McMillan on his 1840 exploration from Numbula Munjie (present-day Ensay) to the LaTrobe River, west of Sale. On 22 January 1840, Macalister wrote in his diary: 'Left Shearing Flat on Cameron's River.... Saw a flock of turkeys about half a mile from the river on a small plain rising from the bank of the river'. (quoted in Cox undated,

p. 34). 'Cameron's River' is now known as the Avon, and 'Shearing Flat' is between present-day Boisdale and Stratford.

Two days later, on 24 January 1840, he noted, 'On travelling 1 miles (sic) came to a plain about 16 miles long and 6 broad. Can see all the way to the mountains without a tree. The grass not quite as good as on the plain yesterday.... Some turkeys are on the plain'. (Cox undated, p. 34). The plain referred to extended south of the Thomson River, in the Heyfield - Nambrok - Kilmany area.

Finally, on the 29 January, Macalister wrote, 'In passing over the Macalister plains *feast of the Macalister River, between present-day Maffra and Sale* saw emus and turkeys in abundance (my italics), but could not get within shot of them'. (Cox undated, p. 35). These three records encompass a distance of about 20 kms, in an east-west direction, from the Nambrok region to the Avon River between Boisdale and Stratford.

Clark (1947, p. 22), provides another record of Bustards, from 1847 or 1848: 'Towards Traralgon he mentions seeing a flock of wild turkeys on the plain, a bird once plentiful but never now seen in Gippsland and very rarely in Victoria'. As far as I can tell, the only large plain 'towards Traralgon' was between Heyfield, Nambrok and Kilmany, and this record probably refers to this area.

Finally, Mrs Montgomery, who wrote some of the best descriptions of the early landscape around Sale, provides the following reminiscence, written in 1916, and referring to the 1850's:

'We stayed (at the Heart, south-east of Sale) ... for a month and spent the time fishing, shooting and driving over the magnificent plains. These plains extended over a vast expanse of country, reaching as far as Maffra which was then unknown as a township. I well remember the splendid game brought

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in by the shooting parties — wild turkeys often weighing eighteen or twenty pounds — and many braces of wild duck, teal and pigeon. Nothing like the bags of those days are to be had now'. (In Leslie and Cowie 1973, p. 101)

Mrs Montgomery also noted, from the plains between Sale and Boisdale, 'flocks of that truly elegant bird, the native companion (or Brolga), with its beautiful french-grey body contrasting vividly with its scarlet beak' (Leslie and Cowan 1973, p. 107).

The above records all refer to 'plains'. At the time of European settlement, there were about 600 sq. kms of treeless, or sparsely timbered, plains between Sale, Heyfield, Newry and Maffra, and from Boisdale to south of Stratford (author, unpub.). These native grasslands were presumably dominated by Kangaroo Grass (*Themeda triandra*) and perhaps Tussock-grass (*Poa labillardieri*), and they were surrounded by riverine scrubs and grassy woodlands dominated by Forest Red Gum (*Eucalyptus tereticornis*), She-oaks (*Allocasuarina verticillata* and *A. littoralis*), Silver Banksia (*Banksia marginata*) and other trees. The original native grasslands have been converted to irrigation districts, and no remnants are known to survive.

In addition to the above records of Bustards from the central Gippsland plains, an isolated record exists from far east Gippsland. In an article entitled 'Mallacoota Notes', Gray (1933) wrote that, 'The Australian Bustard has been reported in the district? No other details were provided.

From the fragmentary accounts above, Bustards appear to have been common on the central Gippsland plains at the time of European settlement, occurring as far east

as the Mallacoota district in far East Gippsland. In central Gippsland, their numbers had diminished by the turn of the century (see Mrs Montgomery's quote above) - before the arrival of rabbits (and rabbit poisoning) between 1900 and 1910 (Fletcher 1988) - and they were locally extinct, along with their grassland habitat, by the 1940's (Clark 1947).

Acknowledgements

Doug Robinson kindly commented on this article and found the reference to Bustards from Mallacoota.

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Birds feeding on the Tree Violet *Hymenanthera dentata*

Helen I. Aston*

From 29 March to 1 April 1991 I was camped with members of the Bird Observers Club of Australia at 37° 36'S., 146° 38'E., along the Wellington River, about 3 kilometres north of Licola, Victoria. Shrubs of the Tree Violet (*Hymenanthera dentata*) were abundant along the river valley, edging the stream and forming regeneration clumps in adjacent cleared pasture. The shrubs were fruiting, bearing masses of small mauve-grey fruits which were obviously a major food for birds at this time. Considerable numbers of Silvereye (*Zosterops lateralis*), King Parrot (*Alisterus scapularis*), and Crimson Rosella (*Platycercus elegans*), and several Black-faced Cuckoo-shrike (*Coracina novaehollandiae*) and Olive-backed Oriole (*Oriolus sagittatus*) were all seen on each day of the camp spending long sessions feeding on the fruits.

Hymenanthera dentata, as currently defined, is a complex of widespread and variable shrubs in south-eastern Australia, occurring from lowlands to the alps, often amongst rocks and usually along creeks. The fruits are sub-globular, 4-5(-7) mm diameter, mauve-grey to purplish-black when ripe, occurring prolifically and conspicuously along the branches. It could be expected that they would attract many species of birds and possibly reptiles when the shrubs are fruiting. However, there are only two published records of birds feeding on them. Fleming (1976) recorded the Silvereye feeding on Tree Violet fruits along

the Yarra Valley in suburban Melbourne, and Rowley and Vestjens (1973) reported the species as a food source for both the Australian Raven (*Corvus coronoides*) and the Little Raven (*C. mellori*). These two reports of *Hymenanthera dentata* being eaten by birds were the only ones located by Barker and Vestjens (1989 and 1990) when compiling their comprehensive lists of food of Australian birds.

It seems that many sightings of birds feeding on Tree Violet fruits are going unrecorded. From the obvious relish with which they were devoured by the birds at Licola I expect that many more species will be found to be users of this readily available food supply. Mr Dale Tonkinson, c/o Department of Botany, La Trobe University, Bundoora 3083, would be glad to have details of any further observations. He will be spending part of his time over the next five years investigating the biology and taxonomy of the *Hymenanthera dentata* complex.

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Phillips, A. and Watson, R. (1991). *Xanthorrhoea: Consequences of 'Horticultural Fashion'*. *The Victorian Naturalist*, **108** (6): 130-133.

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Tues 7 Fauna Survey Group Meeting. Update of Research into Leadbeaters Possum and The Implication for Management of the Species and its Habitat - Malcolm McFarlane. Herbarium Hall 8 p.m.

Thurs 9 Botany Group Meeting. Members Night. Herbarium Hall 8 p.m.

Mon 13 General FNCV Meeting. Fungi of South-eastern Australia - Bruce Fuhrer. Herbarium Hall 8 p.m.

Wed 15 Microscopy Group Meeting. Rocks and Polarised Light - Philip Bock. Astronomer's Residence 8 p.m.

Sat 18 - Sun 19 Fauna Survey Group Field Survey. Yellow-bellied Gliders Survey at Mt. Cole. Contact Russell Thompson, 434 7046.

Sat 25 Botany Group Excursion. Monash Library and Botany School Garden. Leader Annabel Cahill. Contact Joan Harry, 850 1347.

August

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Tues 4 Fauna Survey Group Meeting. The Statistical Design of Wildlife Surveys - Mick Keogh. Herbarium Hall 8 p.m.

Wed 5 Geology Group Meeting. Herbarium Hall 8 p.m. Contact Graeme Love, 282 5187.

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Thurs 13 Botany Group Meeting. Mosses and Liverworts - Arthur Thiess. Herbarium Hall 8 p.m.

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Cover Photo: (Neobatrachus pictus), Mallee Spadefoot Toad, taken at Jilpanger,
Christmas Fauna Survey 1991, *by Andrea Dennis*.

Induration of Ferruginous Shore Rock Outcrops

Eric C.E. Bird and Neville Green*

Introduction

Some rocks that outcrop in cliffs and shore platforms on the coast of Victoria have become more resistant to erosion since they were exposed to the atmosphere. On the Pleistocene dune calcarenites of the Nepean Ocean coast, for example, cliff faces have been superficially hardened, especially on headlands, and an intertidal horizon exposed as the cliffs retreat has been sufficiently indurated to persist as a wide almost horizontal shore platform. This hardening has been attributed to precipitation of carbonates from interstitial groundwater, so that cavities in the original sandstone have become filled with cementing material (Hills 1971).

Similar features have been observed on ferruginous sandstones on the shores of Port Philip Bay, including the Black Rock Sandstone between Elwood and Mordialloc, the Baxter Sandstone between Frankston and Mount Martha, and the Moorabool Viaduct Sand between St Leonards and Indented Head on the Bellarine Peninsula. These formations are of Upper Miocene to Lower Pliocene age (Abel 1976), and their coastal outcrops consist of stratified, often cross-bedded, coarse to fine quartzose sands with associated gravel and clay horizons, and some fossil shells and plants preserved in ironstone. In places they are slightly calcareous. The strata are horizontal or gently folded, with patterns of vertical jointing, and in cliffs and shore platforms they are being dissected by marine erosion along joints and bedding planes. The rocks vary in colour from grey and yellow to brown and reddish-brown according to the nature and proportion of iron compounds present, which stain the quartz sand grains and occupy interstitial cavities. In general, the darker rocks contain a high proportion of ferruginous compounds, and are more strongly indurated.

* Department of Geography, University of Melbourne

Coastal outcrops of these sandstones show successions of rocky promontories and embayments (Bird 1987). On the promontories the sandstones are harder and darker, while in the intervening bays they are softer, and form retreating cliffs or sloping vegetated bluffs. It is evident that, as the coastline receded, promontories persisted on sectors where the rock formations were initially a little harder than in the more rapidly retreating bays, often because the strata were more massive. This contrast has subsequently been accentuated by the induration of headland outcrops. At Mouth Eliza, for example, Daveys Point and Pelican Point are headlands of dark brown sandstone, while the intervening bay has a sandy beach backed by yellow and light brown cliffs of softer sands, sandstones and clays. Both headlands have heaps of fallen Baxter Sandstone, which are darker and harder in the zone frequently splashed by the sea.

At Red Bluff, Sandringham, there is a cliff 34 metres high cut in relatively unconsolidated yellow and grey Red Bluff Sand overlying dark brown Black Rock Sandstone, which protrudes as a basal ledge. The cliff base is fringed by fallen blocks and boulders that have been indurated in the intertidal (between high and low tide) and supralittoral (just above high tide) zones, subject to frequent wave splash and sea spray.

At Black Rock Point the Red Bluff Sand is pale grey and soft in gullied cliff face, and underlain by firmer yellow and brown Black Rock Sandstone which outcrops at the base of the cliffs and in the gently undulating shore platform (Bird and Rosengren 1987). Outcrops of this more coherent sandstone are almost horizontal, forming ledges on minor promontories, and a shore platform that ends in a steep drop along the seaward margin. At the cliff base the Black Rock Sandstone is friable, but in the minor promontories it becomes



Fig. 1. Cliff and shore platform at Black Rock Point, showing Red Bluff Sand in the cliff face and Black Rock Sandstone at the cliff base and on the shore platform. At A the Black Rock Sandstone is relatively soft, at B it is harder, and at C strongly indurated.

darker and harder, and across the shore platform it becomes still darker and more resistant towards the seaward margin, where it is being undercut by marine erosion (Fig. 1). Boulders of hard dark brown sandstone have been dislodged and thrown up on to the shore platform by storm waves.

Induration on exposure to the atmosphere is a rapid process, well known to quarrymen. South of Black Rock, cliff outcrops of coherent Black Rock Sandstone were quarried in the mid-nineteenth century for blocks that were left for a few months to harden before use in the construction of Black Rock House, the first building in this area, dating from 1856. The former quarry can still be seen on the nearby coast, behind the undercliff walk, where the quarried rock surface has also been darkened and superficially indurated.

Similar hardening of ferruginous sandstone is seen between Table Rock Point and Mentone Corner, Beaumaris, in the slowly-receding cliffs that parallel the



Fig. 2. Cliffs at Beaumaris, showing boulders of Black Rock Sandstone that have fallen from the cliff and become indurated on the shore.

Beaumaris Monocline (Fig. 2). The Black Rock Sandstone is here brown and compact, divided by vertical joints and horizontal bedding-planes. Marine erosion along these divisions has displaced blocks of sandstone that have fallen from the cliffs from time to time (Bird 1990). Heaps of large joint-bounded blocks have accumulated locally at the cliff base, where they have been washed and splashed by the sea. They soon become hardened, and may persist for many decades, protecting the cliff from marine attack. Eventually they disintegrated, and are worn down and dispersed by wave action, until the cliff base is again exposed to marine erosion, and undercut.

Further examples may be seen along the Mornington coast, where blocks of Baxter Sandstone have fallen from the cliffs and become hardened into an apron of boulders protecting the cliff base. This natural armouring is similar to the artificial rock ramparts emplaced by coastal engineers to combat cliff erosion.

The process of induration

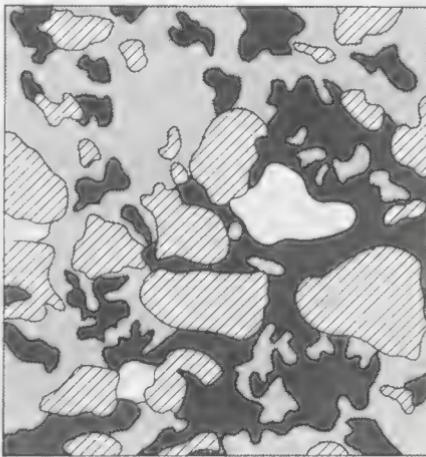
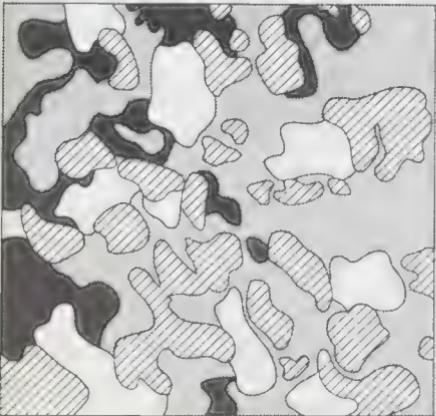
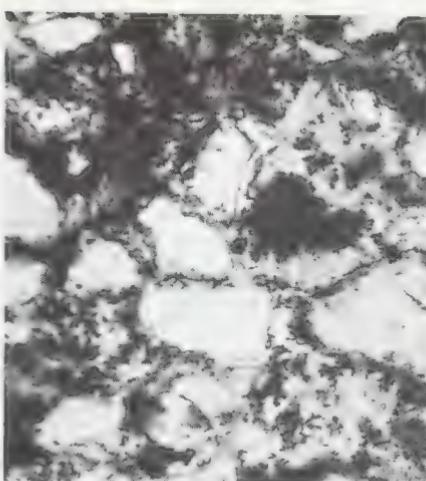
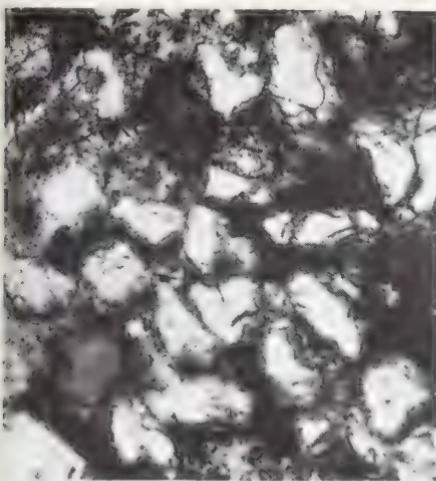
Induration is the outcome of migration and deposition of iron compounds in these rocks. The oxides of iron that commonly coat quartz sand grains and form interstitial fillings in these sandstone formations can be dissolved by percolating groundwater and carried in solution to be precipitated elsewhere. Inland borings through the Black Rock Sandstone have shown that initially these are soft silty sands containing the pale grey or greenish mineral glauconite, a complex silicate of aluminium and magnesium which contains both ferrous and ferric iron. This mineral is dissolved in percolating groundwater and when it is precipitated in a dry environment, oxidation of the ferrous iron occurs, forming less soluble ferric minerals such as yellow to brown goethite and reddish haematite. Such precipitation can occur between sand grains, cementing soft sandstone into harder rock formations.

Examination of shore outcrops of Black Rock Sandstone has shown that induration is superficial, and appears to be due to the

accumulation of insoluble ferric oxides, mainly goethite, in the surface layers. When the rock mass is saturated by percolating rain water some of the iron compounds within the rock mass are dissolved, and as the rock dries these concentrate in the surface horizons, to be precipitated interstitially in such a way as to bind the sand grains more firmly as a resistant crust. This 'case hardening' can be detected when pieces are broken off with a geological hammer, showing that the underlying rock is softer and paler.

The accompanying photomicrographs of thin sections show stages in the interstitial precipitation of goethite in samples from Black Rock Point. Figure 3 is a representation of freshly exposed friable sandstone with little cementing material taken from the cliff face; Figure 4 is a section through harder rock from the base of the cliff, with an increased proportion of goethite cement; and Figure 5 shows strongly indurated material, from the outer edge of the shore platform, with almost all the interstitial cavities occupied by massive goethite. The sections confirm that there has been augmentation of ferric compounds near the surface since the Black Rock Sandstone was exposed to the atmosphere, and it is deduced that these have been leached from the interior and precipitated in an increasingly resistant surface crust.

Evidence of movement of groundwater towards the cliff face (Fig. 6) also includes the exudations of very fine white quartz sand seen on outcrops of Red Bluff Sand (Fig. 7) and similar powdery brown material on cliff and shore outcrops of Black Rock Sandstone. These accretionary exudations are produced by seepage from the interior, especially during and after wet weather. They include soft, adhering ridges and mounds, some arranged into downwashed stripes, standing out up to 5 millimetres from the cliff face. Towards the cliff base they have been washed away by waves, and on the cliff face they dry out and eventually flake away - there are no persistent cemented ridges of this material.

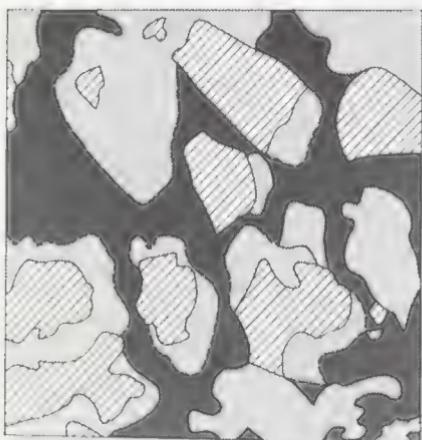


Quartz
 Cryptocrystalline goethite
 Massive goethite
 Cavity

Quartz
 Cryptocrystalline goethite
 Massive goethite
 Cavity

Fig. 3. Photomicrograph (combined transmitted and reflected light) and key diagram of a section through relatively soft Black Rock Sandstone (A in Fig. 1) showing cryptocrystalline goethite patchily cementing angular quartz grains. Field of view 1.00mm.

Fig. 4. Photomicrograph (combined transmitted and reflected light) and key diagram of a section through harder Black Rock Sandstone (B in Fig. 1), showing an increase in the proportion of cementing goethite. Field of view 0.5mm.



- [Diagonal hatching] Quartz
- [Diagonal hatching with light areas] Quartz partly concealed by cryptocrystalline goethite
- [Light gray] Cryptocrystalline goethite
- [Dark gray] Massive goethite
- [White] Cavity

Fig. 5. Photomicrograph (reflected light) and key diagram of a section through strongly indurated Black Rock Sandstone (C in Fig. 1), showing massive goethite cementation. Field of view 0.5mm.

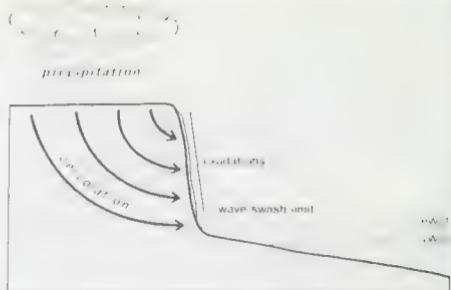


Fig. 6. Percolation of groundwater producing exudation on the cliff face.

Black Rock Sandstone outcrops also show patchy coastings of white salt precipitated when rock surfaces splashed with sea water dry out, but this is dissolved again when the rock is wetted, either by sea or rain water, and does not persist to indurate rock surfaces.

The groundwater seepage that exudes this fine-grained material also carries iron compounds in solution into the outer layers of the rock, where they are precipitated as the seeping moisture dries out. Hardening of interstitial precipitates, by oxidation to ferric compounds mainly goethite, is the primary cause of induration of these shore outcrops.

Conclusion

Weathering by physical, chemical and biological processes usually results in disintegration and decomposition of rock surfaces (Ollier 1969), but induration is a form of weathering that leads to the hardening of rock surfaces. This analysis has shown that induration of ferruginous sandstones on the shores of Port Philip Bay results from the interstitial precipitation of goethite, a ferric oxide produced by oxidation of ferrous compounds, notably glauconite.

It is hoped that the present article will promote discussion of ferruginous induration, a process that has so far received little attention in the literature of coastal geomorphology.



Fig. 7. Surface exudations of very fine sand on the cliff face at Black Rock Point. Ruler approximately 160 centimetres long.

Acknowledgements

We are grateful to Dr Bob Bourman, University of South Australia, for discussion of the problem in the field, to Ms Wendy Nicol for preparing the photomicrographs and Ms Chandra Jayasuriya for drawing the diagrams.

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Notes from the National Herbarium of Victoria No. 12
Type Specimens in Botany

Ian Clarke*

This article is the fourth in a series dealing with aspects of botanical nomenclature and related topics that began in *The Victorian Naturalist* 108: (5). An understanding of the contents of previous articles, while perhaps not essential, has been assumed.

The concept of typifying botanical names, i.e., of designating a particular specimen as the "type," dates from the writings of the Swiss botanist Augustine Pyramus de Candolle (1778-1841). In its current form it was adopted in 1959, at the International Botanical Congress at Montreal.

The most recent edition of the International Code of Botanical Nomenclature (ICBN), which governs the naming of plants, was published in 1988. The second principle of the Code, together with articles 7 to 10 and 37, deal with 'nomenclatural types'.

The rules now require that when a plant species is named for the first time, a single specimen must be designated as the 'nomenclatural type'. This specimen is known as the **holotype**, (E.g. 1). Although this is an older example from a time before the current rules were in force, a similar practice was then followed and it will still serve to illustrate the principle.

	name	original author	place of publication	
1.	13. <i>Atriplex exilifolia</i> F. Muell., <i>Fragm.</i> 7:9 (1869)			
	T: Western Australia, <i>J. Drummond</i> 4: 249; holo: MEL, iso: K, PERTH.			holotype housed at MEL

Atriplex exilifolium.
(Sect. *Teutiopsis*.)

Fruticulosum, procumbens, monoicum, lepidoto-canescens, *foliis parvis orbiculari-vel ovato-rhombeis integrerrimis* vel repandulis, floribus utriusque sexus glomeratis axillaribus, *sepalis fructus parvis rhombeis integrerrimis* basi concretis latere exappendiculatis.

In Australia occidentali; Drummond 249.

Folia pleraque 2-3^{lin}looga. Glomeruli foruim masculorum sparsi v. pauci conferti. Fructus tantum statu semimature visi, tunc lineam vix excedentes.

type collection
extract from Mueller's Fragments Phytographiae Australiae

Explanation of Example 1

The first two lines are taken from the Flora of Australia v. 4 (1984), page 102, and deal with the entry for *Atriplex exilifolia*. The author of the name is Ferdinand Mueller and he published it in his series of volumes called *Fragments Phytographiae Australiae*, volume 7, page 9, a portion of which has been reproduced. Mueller cites the collection "In Australia occidentale (i.e., WA); Drummond 249". Preserved in the National Herbarium of Victoria (MEL) is a specimen of James Drummond's 4th series of collections, No. 249, from Western Australia and although Mueller would not have known it as such, this is the holotype.

* National Herbarium of Victoria, Birdwood Ave, South Yarra, 3141.

The designation of the type specimen is intended to establish beyond doubt the application of the name - a botanical name and its type specimen are effectively one and the same. Whatever nomenclatural decisions are subsequently made about the type specimen, the original name stays with it, either as an accepted name or as a synonym, (E.g. 2).

2.	36. <i>Atriplex semilunaris</i> Aellen. <i>Bot. Jahrb. Syst.</i> 68: 382 (1937)
type collection for <i>Atriplex semilunaris</i>	T: banks of Ashburton River, Minderoo, W.A. 11 Oct. 1905. <i>A. Morrison</i> 15119; lecto: K. n.v., iso: PERTH. <i>fide</i> P.G. Wilson, <i>Fl. Australia</i> 4: 325 (1984).
	<i>A. semilunaris</i> var. <i>gracilis</i> Aellen. <i>Bot. Jahrb. Syst.</i> 68: 383 (1937). T: Onslow, mouth of Ashburton River, W.A. 15 Oct. 1905, <i>A. Morrison</i> 15120; holo: K.
lectotype housed at KEW	holotype at KEW

this variety not currently accepted — placed in synonymy

type collection of variety (remains the type even though the name is not in use)

Typification is purely a nomenclatural procedure - the type specimen is not necessarily 'typical' of the species in terms of morphological variation.

Various other categories of types are recognised, besides the holotype, to cope with the numerous nomenclatural situations that have arisen during the period of development of the Nomenclature Code. Such situations include the citing of more than one specimen with the description of a new species, which was often done by early botanists like Ferdinand von Mueller or George Bentham. These specimens are not all simply taken as holotypes. In a few instances the type has taken another form such as an illustration.

The process of typification is followed through up to the level of family. Generic names are typified by the same type as one of the included species. Family names take the same type as that of the generic name on which they are based. Intermediate ranks are similarly treated.

Thus, the **family** name SOLANACEAE (nightshade family) is based on the same nomenclatural type as the generic name *Solanum*. The **generic** name takes the same type as one of the species, in this case, *S. nigrum* (black nightshade). The **species** *Solanum nigrum* L. has as its type a particular specimen (No. 248.18) housed in the herbarium of the Linnaean Society of London. In other words, specimen No. 248.18 is the type for the higher ranks as well as its own species. The type specimens of other solanums serve only their respective species.

When a species is transferred to another genus, the specific epithet is retained (unless already in use in the new genus, in which case a new one must be coined) and a **new combination** of generic name and specific epithet is made. *The type specimen of the original name then serves as the type of the new combination.* (E.g. 3) The original name becomes a synonym and may be known as the **basionym** of the new combination.

Similarly when a variety is raised to the rank of species, the epithet is often retained (although this is not mandatory). *The type of the variety may be retained as the type of the species* (E.g. 4). The reverse situation can also occur when a species is reduced in rank (E.g. 5).

Type specimens are thus vital parts of the taxonomic botanist's tools of trade. Examination of the type specimen indicates exactly to which kind of plant the author intended a name to apply and should thereby clarify any ambiguity that may arise from the written description.

Contributions

current name

bas. onym.

3. Wilson has transferred Mueller's species to the genus *Maireana*

extract from Mueller's *Fragmenta Phytographiae Australiae*

15. *Maireana dichoterra* (F. Muell.) Paul G. Wilson, *Nuytsia* 2: 28 (1975)
Kochia dichottera F. Muell., *Fragm.* 8: 37 (1873). T: Bowen Downs, Qld, C.W. Birch; holo: MEL

Salsolaceae

Kochia dichottera

Erecta, ramulis cano-tomentosis, foliis longiuscule lineraribus planiusculis sericeo-pubescentibus, floribus albido-tomentosis dignis, fructibus supra alam basalem teneram horizontali-expansam e lobis quinque connatis ortam sursum in alas quinque verticali-longitudinales undulatas late productis.

In planitebus basalticis Bowen's Downs; C.W. Birch.

type collection

Bentham's variety has been raised to specific rank by Wilson

extract from Bentham's *Flora Australiensis*

original place of publications of Bentham's variety

4. 7. *Rhagodia latifolia* (Benth.) Paul G. Wilson, *Nuytsia* 4: 228 (1983)

R. crassifolia var. *latifolia* Benth., *Fl. Austral.* 5: 155 (1870). T: Dirk Hartog Is., W.A., Jan 1822, A. Cunningham 321; holo: K, iso: MEL.

5. *R. crassifolia*, *R. Br. Prod.* 408. A dwarf or diffuse much branched scrubby shrub, or the branches somewhat elongated in narrow-leaved forms, nearly green or more or less hoary-tomentose. Leaves mostly alternate, linear or scarcely oblong in the typical form, rarely cuneate or almost obovate in some varieties, obtuse, confracted into a short petiole, rather thick, flat or concave, rarely $\frac{1}{2}$ in. long. Flowers and fruits small, clustered or rarely solitary, in short terminal nearly simple interrupted spikes or slightly branched panicles. Fruiting perianth not exceeding the fruit.

N. Australia. Sturt's Creek, *F. Mueller*.
Victoria. Wimmera, *Dallachy*.

S. Australia. Kangaroo Island. *R. Brann*; towards Spencer's Gulf, *Warburton*.

W. Australia. Scattered over the treeless plains N.W. of the Great Bight, *Delisser*; Point Henry and Murchison river, *Oldfield*.

Var. *latifolia*. Leaves obovate ovate hastate or broadly oblong all very obtuse and under $\frac{1}{2}$ in. long. - *R. crassifolia*. Mog. in DC. Prod. xiii, ii. 52 — Dirk Hartog's island, A. Cunningham.

the type collection of the variety serves the species also

5.

6b. *Rhagodia baccata* subsp. *dioica* (Nees) Paul G. Wilson, *Nuytsia* 4: 225 (1983)

R. dioica Nees in Lehm., *Pl. Preiss.* 1: 636 (1845). T. Fremantle, W.A., *L. Preiss* 1253; lecto: K. iso: MEL, *fide PG. Wilson, op. cit.* 223.

1. ***Rhagodia dioica* N. ab E. fruticosa, erecta, ramis inermibus acute angulato-costatis, foliis oppositis alternisve oblongis obtusis cum mucronulo in petiolum attenuatis planis glaucis subitus pallidioribus puberulo - pulverulentis, spicis terminalibus compositis, masculis laxioribus.**

In arenosis ad iluvium Cygnorum prope oppidulum Fremantle, Decembri a. 1838. (♀) Herb. Preiss. No. 1253, ibidemque ad littora maris arenosa, eodem tempore No. 1254.

Wilson has reduced this species to a subspecies of *R. baccata*
extract from Lehmann's Plantae Preissiana

the type collection of the species serves the subspecies also

The considerable value of type specimens to nomenclatural interpretation and stability demands that they be looked after carefully. Recommendation 7A of the ICBN states that 'It is strongly recommended that the material on which the name of a taxon is based, especially the holotype, be deposited in a permanent, responsible institution and that it be scrupulously conserved'.

At the National Herbarium of Victoria type specimens are mounted on firm white card and each is enclosed in a red-bordered folder. Details of the species name, and date and place of publication are recorded on the outside together with the current name if there has been a change.

Further reading

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The Temporary Home of Some Remnant Plants

The Fawkner Memorial Park

J. Stewart**

Introduction

An article in *The Victorian Naturalist* Vol. 107 No. 1 (1990) 'A species list for Merri Creek area (Melbourne Victoria) compiled in 1896' by Ian Clarke of a plant list by H.M.R. Rupp (1872-1956), prompted me to submit this list of species from Fawkner Memorial Park, an area roughly 1 km west of the Merri Creek.

The Fawkner Memorial Park has an area of 176 hectares established as a cemetery in 1905 with traditional monumental areas, and in later years with more modern, lawn grave areas. The underlying rocks are weathered Silurian shales overlain in some places by Tertiary basalt with some Quarternary sand in patches. The soils are a mixture with light clay, sandy loam and dark clay. A small permanent stream the Merlynton Creek passes through the grounds and it is on the banks and nearby ground where most of the native plants still survive.

The function of a cemetery is to dig holes for the interment of a coffin then to fill the hole in again, with the result that there

is a certain amount of spoil left over. To get rid of this, any hollows in unused ground are filled in and artificial mounds are built on top of the original surface leaving very little of it still exposed. With all this disturbed ground weeds are rife, and over the years various methods - scythes, fire and a number of herbicides - were used to combat the inevitable growth of grass and weeds amongst the tombstones and monuments. Some of the herbicides left residues that went on killing trees and shrubs well away from the areas that were sprayed, today no residual sprays are used.

Some of the land now being utilised was until a few years ago used for grazing, this was a *Themeda* grassland with a remnant of box (*Eucalyptus melliodora*) now being overrun by paspalum and phalaris.

This list has been compiled over quite a few years observation, during which time some species have disappeared as more of the original surface is covered. I have left them on the list with a note. The list of plants does not include any of the plants that have been deliberately planted as part of the gardens or features.

DICOTYLEDONS

AMARANTHACEAE

Alternanthera denticulata
* *Amaranthus retroflexus*

Lesser Joyweed
Red Root Amaranth

APIACEAE

* *Apium graveolens*
Eryngium ovinum
* *Foeniculum vulgare*

Wild Celery
Blue Devil
Fennel

APOCYNACEAE

* *Vinca major*

Blue Periwinkle

** 19 Connell St, Glenroy, Victoria 3046.

* introduced species

ASTERACEAE

- * *Arctotheca calendula*
- * *Conyza bonariensis*
- Craspedia glauca*
- * *Cynara cardunculus*
- * *Hypochoeris radicata*
- * *Picris echioides*
- Pseudognaphalium luteoalbum*
- * *Silybum marianum*
- * *Sonchus oleraceus*
- * *Taraxacum* Sect. *Hamata*
& Sect. *Vulgaria*
- * *Tragopogon porrifolius*

- Capeweed
- Flax Leaf Fleabane
- Common Billy-buttons
- Artichoke Thistle
- Cat's Ear
- Bristly Ox Tongue
- Jersey Cudweed
- Variegated Thistle
- Common Sow Thistle
- Dandelion
- Salsify

BORAGINACEAE

- * *Echium plantagineum*

- Paterson's Curse

BRASSICACEAE

- * *Brassica tournefortii*
- Lepidium pseudohyssopifolium*
- * *Raphanus raphanistrum*
- * *Sisymbrium orientale*

- Wild Turnip
- Peppergrass
- Wild Radish
- Wild Mustard

CAMPANULACEAE

- Isotoma fluviatilis* ssp.
australis
- Pratia pedunculata*
- Wahlenbergia communis*
- Wahlenbergia stricta*

- Swamp Isotome
- Matted Pratia
- Tufted Bluebell
- Tall Bluebell

CARYOPHYLLACEAE

- * *Cerastium glomeratum*
- * *Silene gallica*

- Mouse-ear Chickweed
- French Catchfly

CASUARINACEAE

- Allocasuarina verticillata*

- Drooping She-oak

CHENOPODIACEAE

- Atriplex semibaccata*
- * *Chenopodium album*
- Einadia hastata*
- Einadia nutans*

- Creeping Saltbush
- Fat Hen
- Saloop
- Nodding Saltbrush

CLUSIACEAE

- Hypericum japonicum*

- Matted St. John's Wort

CONVOLVULACEAE

- * *Convolvulus arvensis*
- Convolvulus erubescens*
- Dichondra repens*

- Common Bindweed
- Pink Bindweed
- Kidney Weed

DIPSACACEAE

- * *Dipsacus fullonum*

- Teasel

DROSERACEAE	Tall Sundew (lost, the habitat was drained)
<i>Drosera peltata</i> ssp. <i>auriculata</i>	
EUPHORBIACEAE	Petty Spurge
* <i>Euphorbia peplus</i>	
FABACEAE	Eutaxia
<i>Eutaxia microphylla</i> var. <i>diffusa</i>	Small-leaved Eutaxia
<i>Eutaxia microphylla</i> var. <i>microphylla</i>	Running Postman (disappeared in last few years.)
<i>Kennedia prostrata</i>	Tough Scurf-pea
<i>Psoralea tenax</i>	Matted Bush Pea
<i>Pultenaea pedunculata</i>	Narrow Leaf Clover
* <i>Trifolium angustifolium</i>	Suckling Clover
* <i>Trifolium dubium</i>	Furze
* <i>Ulex europaeus</i>	Narrow Leaf Vetch
* <i>Vicia sativa</i> ssp. <i>nigra</i>	Common Vetch
* <i>Vicia sativa</i> ssp. <i>sativa</i>	
FUMARIACEAE	Wall Fumitory
* <i>Fumaria</i> <i>Erghraea</i>	
GENTIANACEAE	Common Centaury
* <i>Centaurium erythraea</i>	
GERANIACEAE	Common Heron's Bill
* <i>Erodium cicutarium</i>	Cut Leaf Geranium
LAMIACEAE	Horehound
* <i>Marrubium vulgare</i>	Wild Sage
* <i>Salvia verbenaca</i>	
LORANTHACEAE	Drooping Mistletoe
<i>Amyema pendulum</i>	
LYTHRACEAE	Small Loosestrife
<i>Lythrum hyssopifolia</i>	
MALVACEAE	Tree Mallow
* <i>Lavatera arborea</i>	Small Flowered Mallow
* <i>Malva parviflora</i>	Red Flowered Mallow,
* <i>Modiola caroliniana</i>	Caroline Mallow
MIMOSACEAE	Gold-dust Wattle
<i>Acacia acinacea</i>	Lightwood
<i>Acacia implexa</i>	Blackwood
<i>Acacia melanoxylon</i>	Black Wattle
<i>Acacia mearnsii</i>	Hedge Wattle (Cleared several years ago.)
<i>Acacia paradoxa</i>	Golden Wattle
<i>Acacia pycnantha</i>	
MYRTACEAE	River Red Gum
<i>Eucalyptus camaldulensis</i>	
<i>Eucalyptus melliodora</i>	Yellow Box

ONAGRACEAE	
<i>Epilobium hirtigerum</i>	Narrow Leaf Willow Herb
OXALIDACEAE	
* <i>Oxalis articulata</i>	Pink Flowered Wood Sorrel
<i>Oxalis perennans</i>	Yellow Wood Sorrel
* <i>Oxalis pes-caprae</i>	Sourso
* <i>Oxalis purpurea</i>	Large Flowered Wood Sorrel
PITTOSPORACEAE	
<i>Pittosporum undulatum</i>	Sweet Pittosporum
PLANTAGINACEAE	
* <i>Plantago coronopus</i>	Buck's Horn Plaintain
* <i>Plantago lanceolata</i>	Ribwort
POLYGONACEAE	
<i>Persicaria decipiens</i>	Slender Knotweed
* <i>Polygonum aviculare</i>	Prostrate Wireweed
* <i>Rumex crispus</i>	Curled Dock
PORTULACACEAE	
<i>Portulaca oleracea</i>	Common Purslane
PRIMULACEAE	
* <i>Anagallis arvensis</i>	Scarlet Pimpernel
RANUNCULACEAE	
* <i>Ranunculus muricatus</i>	Sharp Buttercup
* <i>Ranunculus sceleratus</i>	Celery Buttercup
ROSACEAE	
<i>Acaena echinata</i>	Sheep's Burr
* <i>Rosa rubiginosa</i>	Sweet Briar
* <i>Rubus fruticosus</i>	Blackberry
RUBIACEAE	
* <i>Galium aparine</i>	Cleavers, Bedstraw
<i>Galium guadichaudii</i>	Rough Bedstraw
SCROPHULARIACEAE	
<i>Veronica gracilis</i>	Slender Speedwell
SOLANACEAE	
* <i>Datura ferox</i>	Fierce Thornapple
* <i>Lycium ferocissimum</i>	African Boxthorn
<i>Solanum aviculare</i>	Kangaroo Apple
* <i>Solanum nigrum</i>	Black Nightshade
THYMELAEACEAE	
<i>Pimelea spinescens</i> subsp. <i>spinescens</i>	Rice-flower
URTICACEAE	
* <i>Urtica urens</i>	Small Nettle

MONOCOTYLEDONS

ARACEAE

* *Zantedeschia aethiopica*

White Arum Lily

CYPERACEAE

Carex inversa

Knob Sedge

* *Cyperus eragrostis*

Drain Flat Sedge

Eleocharis acuta

Common Spike Rush

Isolepis marginata

Tiny Club Rush

Schoenus apogon

Common Bog Rush

IRIDACEAE

* *Gynandriris setifolia*

Thread Iris

* *Homeria miniata*

Cape Tulip

* *Ixia viridiflora*

Ixia

* *Romulea rosea* var. *australis*

Onion Grass

* *Sisyrinchium* sp.

Blue-eyed Grass

JUNCACEAE

* *Juncus acutus*

Sharp Rush

Juncus bufonius

Toad Rush

Juncus holoschoenus

Jointed-leaf Rush

JUNCAGINACEAE

Triglochin procera

Water ribbons

LILIACEAE

* *Allium triquetrum*

Three Cornered Garlic

Bulbine bulbosa

Bulbine Lily

Dichopogon strictus

Chocolate Lily

Dianella longifolia

Pale Flax Lily

Dianella revoluta

Black Anther Flax Lily,

Tricoryne elatior

Spreading Flax Lily

Yellow Rush Lily

MARSILEACEAE

Marsilea drummondii

Common Nardoo

POACEAE

Agrostis avenacea

Brown Grass

* *Aira cupaniana*

Silvery Hairgrass

* *Avena fatua*

Wild Oat

Bothriochloa macra

Redleg Grass

* *Briza maxima*

Quaking Grass

* *Briza minor*

Shivery Grass

* *Bromus catharticus*

Prairie Grass

* *Bromus diandrus*

Great Brome

* *Bromus rubens*

Red Brome

Chloris truncata

Windmill Grass

* *Critesion murinum* ssp.

Barley Grass

leporinum

Couch Grass

* *Cynodon dactylon*

Common Wallaby Grass

Danthonia caespitosa

Brown Black Wallaby Grass

Danthonia duttoniana

Contributions

POACEAE (cont.)

<i>Danthonia penicillata</i>	Slender Wallaby Grass
<i>Dichelachne crinita</i>	Long Hair Plume Grass
<i>Digitaria sanguinalis</i>	Summer Grass
* <i>Ehrharta longiflora</i>	Annual Veldt Grass
* <i>Eleusine tristachya</i>	Goose Grass
<i>Elymus scabrus</i>	Wheatgrass
* <i>Hainardia cylindrica</i>	Common Barb Grass
* <i>Holcus lanatus</i>	Yorkshire Fog
* <i>Lolium perenne</i>	Perennial Rye Grass
* <i>Nassella trichotoma</i>	Serated Tussock Grass
* <i>Paspalum dilatatum</i>	Paspalum
* <i>Paspalum distichum</i>	Water Couch
* <i>Pennisetum clandestinum</i>	Kikuyu Grass
* <i>Pennisetum villosum</i>	Long Style Feather Grass
* <i>Phalaris aquatica</i>	Phalaris
* <i>Phalaris paradoxa</i>	Paradoxa Grass
<i>Phragmites australis</i>	Common Reed
* <i>Poa annua</i>	Winter Grass
<i>Poa labillardieri</i>	Tussock Grass
* <i>Poa pratensis</i>	Kentucky Bluegrass
* <i>Sporobolus indicus</i> var. <i>africanus</i>	Rat's Tail Grass
<i>Stipa nodosa</i>	Variable Spear Grass
<i>Stipa scabra</i>	Rough Spear Grass
<i>Themeda triandra</i>	Kangaroo Grass
XANTHORRHOEACEAE	
<i>Lomandra filiformis</i>	Wattle Mat-rush
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush

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Phytoglyphs - An Aid to the Taxonomy of the Proteaceae

A. Salkin*

Phytoglyphs are preparations of the leaf cuticle. Their value lies in the fact that since the cuticle very closely models the topography of the leaf surface, they can provide information which would be difficult to obtain in other ways and, importantly, phytoglyphs are easy to prepare using only simple materials and methods. They have proven to be useful to help to determine relationships within plants (Johnson and Briggs 1975).

Phytoglyphs have been used in two main ways: in zoological studies to ascertain the diet of animals by comparison of cuticular fragments in faeces with known samples of cuticle (Storr 1961; Williams 1962; Guiler 1971); in botany to aid the determination of botanical tribes, families and genera and species (Cookson and Duigan 1960; Stace 1965; Carr *et al.* 1971; Johnson and Briggs 1975). Phytoglyphs may be obtained from fresh or dried leaves. Even commercially packaged tea-leaves will provide good phytoglyphs.

The cuticle is a very resistant material and only one known micro-organism, *Penicillium spinulosum*, is capable of enzymatically taking apart the polymer (Heinen 1960, 1961). Because the cuticle has a high resistance to oxidizing agents such as strong acids and alkalis, these may be used to remove the underlying epidermal cells. The method is, in fact, similar to those age-old ones of retting or maceration to obtain fibres in such industries as linen and paper-making.

Preparation of Phytoglyphs

The formulae for macerating leaves are so numerous as to be bewildering, the one thing they have in common is that they all use powerful oxidizing agents. Phytoglyphs can be made very quickly by boiling small leaf pieces in 50 - 100% nitric acid. This can be done in 10 - 20 minutes. Whilst this process is fast, it is far too drastic for young

leaves which simply disappear and it also has the disadvantage in that the leaf is difficult to stain. The process is also quite dangerous and should only be performed in a laboratory equipped with a fume hood.

All phytoglyphs in this study, apart from those experiments to find the most suitable medium, have been made using household bleach (3% Sodium Hypochlorite) such as White King for the macerating agent. The action of this is slow and progressive and it never destroys the cuticle. It has been used in weaker dilutions for very young leaves and fossil material.

Small pieces of leaf 5 to 10 mm square are cut from the leaf but avoiding the main vein. Experience has shown that there is little difference between the parts of the leaf-blade, but in order to standardize the procedure material was taken from the middle third. With small leaves such as the adult leaves of *Banksia ericifolia* a fine section of one of the leaf edges was cut off with a blade and the middle third used. The leaf pieces are placed in a glass vial and three-quarters filled with bleach; this is sufficient for 10 pieces of leaf. Maceration is complete when the leaf has lost all of its colour. If after 24 hours the leaves have not cleared, a change of bleach usually accomplishes this. Prolonged immersion in bleach does not appear to have a detrimental effect on the cuticle.

Once maceration is complete the bleach is decanted either by careful pouring or by the use of a pipette. With small pieces of leaf the latter is preferable. The preparations are rinsed over a number of days in 3-4 changes of water and then poured into a petri dish. At this stage the two phytoglyphs, (the upper and lower cuticles) should separate. However, this is not always the case as epidermal cells and, in particular, fibres, cling quite tenaciously. At this stage, if the cuticles do not separate, a small amount of mechanical maceration

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with a fine sable brush usually helps. The phytoglyphs may then be manipulated onto a slide by placing one end of the slide in the petri dish and floating the phytoglyph onto it with the aid of the sable brush. The point of the brush may then be used to manoeuvre the upper and lower surfaces to different parts of the slide. The preparation may then be observed under the microscope. If the surfaces are clear of fibres they may then be stained or returned to vials. It is not essential to stain phytoglyphs because the differences in thickness give quite a good contrast.

Staining phytoglyphs

Various stains have been used but because of the use of an oxidization agent prior to staining it is difficult to assess the chemistry of histochemical reactions.

Toluidine Blue

This is one of the most useful stains in botanical histochemistry, and shows that there is a change in the cuticle after maceration. A fresh cuticle peeled from a banksia leaf and leaves sectioned in G.M.A. show no reaction at all, whereas cuticles that have been bleached stain a dark blue. However, the hairs on the abaxial surface stain purple irrespective of whether they have been bleached or not. This seems to indicate that the hairs are not cuticularized, or if they are, it is not to any great depth. The fact that fossil banksias (i.e. fossil banksia leaves from the Yallourn coal deposits whose leaves have been "pickled") which are in most respects like normal leaves, do have hair bases but no hairs, tends to support this view. It would appear that, like the fibres in the leaf, the hairs are still capable of remaining after maceration because of the preservation of the cell wall. In the case of the hairs this is probably the result of the tightness of fit in the cuticularized hair base.

Crystal or Cresyl Violet

This was the final choice of stain, used for permanency and which stained most of the sections.

Preparations stained in either of these

two stains showed no noticeable deterioration after five years. In some cases stained phytoglyphs which had been stored in vials of tap water for three years showed no sign of stain deterioration.

Mounting

Various methods are suggested for mounting phytoglyphs (Stace 1965), but a quick, effective and permanent method for most purposes is to place the stained preparations in position on a slide. These are firstly air dried and then dried at a higher temperature (usually 40 degrees C.) than room temperature to remove the last of the moisture. Where leaves have been under tension this drying may cause the leaf to twist and buckle. These may be cut into smaller pieces or may be stuck down using a very weak solution of gum arabic. If used very sparingly the gum has no effect on the finished preparation.

A fairly fluid mounting medium is best such as Depex or thinned damar xylene. This is dropped onto the preparation and a cover slip applied. Problems may be encountered with air trapped by cuticular flanges. This is particularly noticeable on the adaxial surface where flanges are deep and the surface is continuous and not broken by stomata. A solution to this problem is to apply the mounting medium and allow this to thoroughly dry. The whole preparation may then be sliced off with a blade and reversed; fresh mounting medium is then applied and a coverslip placed over it. All prepared slides should be labelled with the name of the species and a code number or letter to indicate the provenance. Voucher specimens in this study are held at the Herbarium of N.S.W., and at Melbourne and Monash Universities. These institutions also have photographic catalogues of 72 of the 75 Proteaceae Phytoglyphs.

Cuticles as an aid in the taxonomy of Proteaceae species

Examination of Proteaceae cuticles in this study has shown a number of interesting features: for instance, the cuticle

of a banksia leaf forms a continuous membrane on the outer surface. It penetrates around the epidermal cells as a flange and extends into sub-stomatal spaces. All eastern banksia species except those in the section Oncostyles have a layer of fibres that form a continuous plate under the two layers of epidermal cells (Fig. 1,2,3). These fibres tend to stick to the adaxial surface and usually require mechanical removal. Examination of fossil banksia material indicates that the anatomy, such as shapes of stomata and epidermal cells, is very similar to modern banksias, and this suggests that leaf anatomy is more conservative than floral anatomy. Hence, this is shown to be a useful method of determining relationships between tribes and should be pursued further.

Until recently cuticular studies were not

used to any great extent by neo-botanic taxonomists but were the stock-in-trade of

cu

hb

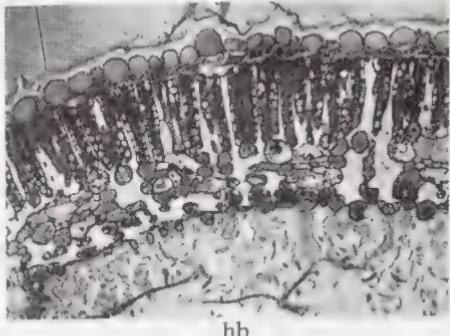


Fig. 1. Transverse section of a Leaf of *Banksia spinulosa* var *cunninghamii*. The cuticle (cu.) is unstained. On the upper surface two hair bases (hb.) stand above the general surface. On the lower surface one complete hair base can be seen as well as the stomata (st.) that make up the unique pattern of this species.

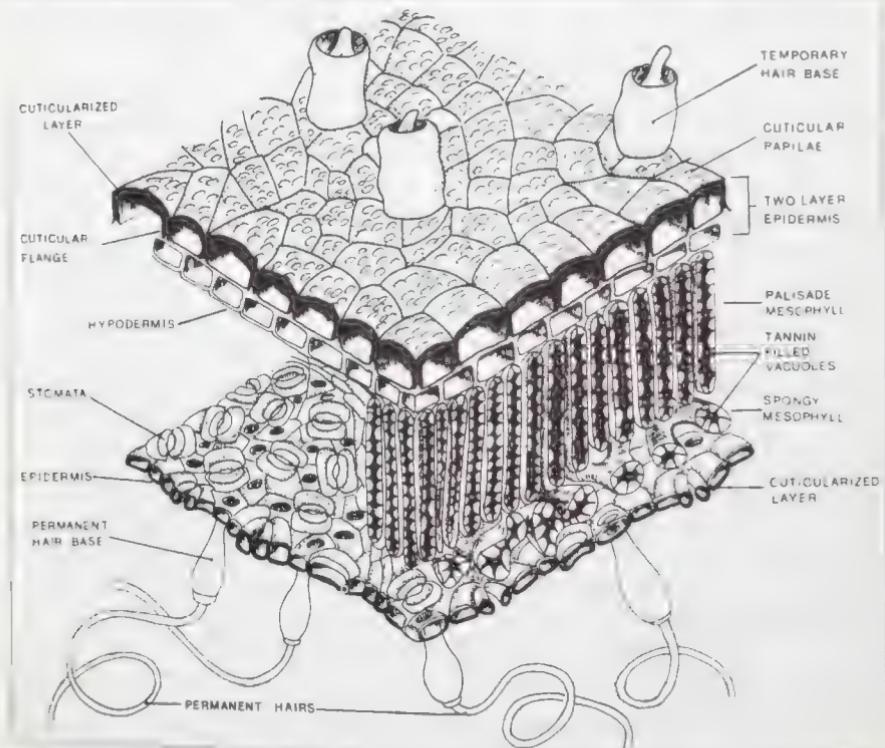


Fig. 2. Isometric view of a portion of a leaf of *Banksia spinulosa* var *cunninghamii* (Sieber ex Reichenbach) A.S. George.



Fig. 3. Transverse section of a leaf of *Banksia spinulosa* var. *cunninghamii* that has been cleaned with bleach, embedded and sectioned. Most of the internal structure of the leaf has been dissolved but parts such as the leaf surface, hair bases, and hairs of the lower surface which have been cuticularised remain. When viewed as a surface preparation the size and shape of the cells and the distribution of stamata hairs, hair bases and cuticular papillae provide information that can be used in separating not only genera but also species. Scale line 100 μ m.

the paleobotanist. This was mainly because the paleobotanist had nothing much else to work with other than remnants of cuticles (apart from pollen). Stace (1965) has given an excellent historical review of cuticular studies on both fossil and modern materials, done mainly in the northern hemisphere. This paper, one of the special editions issued by the British Museum (Natural History), details the history of the subject and reviews the systematic value of the epidermal characters of angiosperm leaves, their anatomical importance, and methods for isolation as well as a suggested routine for their description.

In Australia the method was used as early as the late 1940's by Cookson and Duigan (1950) in a comparison of modern and fossil Banksieae. Carr *et al.* (1971) used the method of cuticular isolation to separate closely related species of the genus *Eucalyptus* and coined the phrase "phytograph" which literally means plant carving or groove: i.e. the impression left behind on the cuticle when the cells of the leaf are removed.

As an aid to understanding the relationship of the Banksieae to the other tribes in the Proteaceae, all but three of the genera have been subjected to cuticular study (*Euplassa*, *Malagasia*, *Panopsis*). Many of these were from herbarium material, (the oldest being *Diastella ericifolia*, collection of Robert Brown 1801), All of which provided acceptable results.

The results of these studies confirm some of the discrepancies found by Johnson and Briggs (1974), as well as discovering further ones. It would appear, using evidence from phytographs that *Grevillea* should be placed in the tribe Knightae rather than Macadamiae. Revision will also need to be done on *Lambertia*, which has an adaxial cuticle indistinguishable from *Banksia* and *Dryandra*, but lacks stomatal crypts on the abaxial surface. Hutchinson (1959) placed only two genera, *Banksia* and *Dryandra*, in the tribe Banksieae but Johnson and Briggs (1974) expanded this tribe to include *Musgravea* and *Austromuellera*. However, evidence from phytographs indicates that

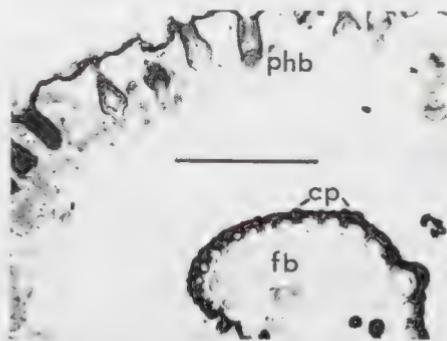
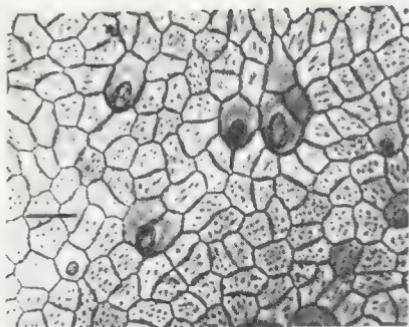
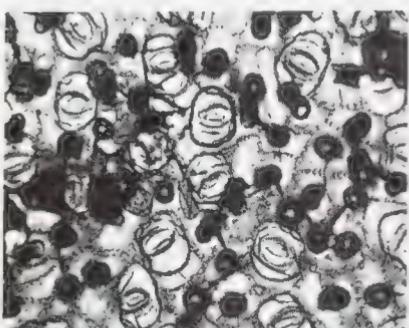


Fig. 4. Transverse section of a portion of a cleared leaf of *Banksia spinulosa* var. *cunninghamii*. The section at the top of the photograph is the lower surface. The permanent hair bases (phb.) and the cuticle of cells can be clearly seen. In the lower part of the photograph is the upper surface. (The cuticle has twisted in the preparation). The cuticular papillae CP can be clearly seen as well as the partial cuticularisation of the vertical cell wall. FB are mainly fibres that support these stiff leaves. Scale line 100 μ m.



upper surface



lower surface

Fig. 5. Phytopglyphs of upper and lower leaf surfaces of *Banksia spinulosa* var. *cunninghamii*. The upper surface has scattered hair bases above heavily cuticularised cells. The dark spots are cuticular papillae characteristic of this species. The lower surface in this species has scattered stamata and hair bases. Scale line 20 μ m.

there is not a strong relationship between the two latter genera, or between them and *Dryandra* and *Banksia*. However, since there are strong correlations between the phytopglyphs of genera in the other tribes, this discrepancy may be an indication of a wider division between these genera than other evidence might suggest. Of these two new genera included in the Banksieae the one that has some similarity is the *Musgravea*. The two species examined *M. stenostachys*, and *M. peterophylla* (Vouchers N.S.W.) have shallow stomatal pits. The very strong relationship between *Banksia* and *Dryandra* phytopglyphs and

the fact that in *Dryandra* there are similarities in the arrangement of stomata to both *Banksia*, section *Orthostylis* and section *Oncostylis* indicates that a classification other than that based on flowers and fruit would show new important phylogenetic relationships. It is possible, and probable (if cuticular changes are more conservative than floral changes) that the division of leaves with stomatal pits and those without, preceded the evolution of flowers in a spike. It is as well to remember that the division of *Banksia* and *Dryandra* based on whether the flowers are formed in a spike or in a capitulum, does not hold good for section *Isostylis* where the flowers are not in a spike.

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Atherosperma moschatum (Southern Sassafras) in the Otway Ranges - a Victim of European Landuse?

Ian D. Lunt*

Australia's rainforests are of considerable biological interest. Three distinctive types of rainforest occur in Victoria: cool and warm temperate rainforest and dry rainforest (Cameron 1990).

Victorian stands of cool temperate rainforest are usually dominated by *Nothofagus cunninghamii* (Myrtle Beech) and/or *Atherosperma moschatum* (Southern Sassafras), often with *Acacia melanoxylon* (Blackwood). *Telopea oreades* (Gippsland Waratah) and *Elaeocarpus holopetalus* (Black Oliveberry) are conspicuous in East Gippsland (Rainforest Technical Committee 1986; Cameron 1990).

Atherosperma moschatum is strangely absent from cool temperate rainforests in the Otway Ranges, a point which has repeatedly been commented upon (e.g. Howard and Ashton 1973; Busby and Bridgewater 1977; Parsons *et al.* 1977; Howard 1981). This absence is surprising as cool temperate rainforests in the Otways are otherwise similar in composition to those in the Central Highlands and South Gippsland (Howard and Ashton 1973; Busby 1984), and the Otway's habitat and climate appear to be suitable for the species (Read and Busby 1990). At least two theories have been proposed to account for this absence (Howard and Ashton 1973; Busby and Bridgewater 1977), and it is generally assumed that *A. moschatum* was absent from the Otways at the time of European settlement.

Recently, while perusing George Bentham's 'Flora Australiensis' (Bentham 1863-1878), I was surprised to find a record which seems to have been overlooked in recent years. Bentham's locality note for *Atherosperma moschatum* reads:

Rare in dense swampy forest gullies towards Cape Otway, more frequent at the sources of the Yarra[,] in the Dandenong ranges, and

in the southern part of Gipps' Land, F. Mueller. (Bentham 1870, p.285).

Bentham's note was modified from an earlier account by Ferdin and Mueller, in 'The Plants Indigenous to the Colony of Victoria' (Mueller 1860-1862). Mueller's locality note reads:

Rare in dense swampy forest gullies towards Cape Otway; more frequent at the sources of the Yarra, in the Dandenong Ranges, in the Western Port district, and in the southern part of Gipps Land, forming at Sealer's Cove a conspicuous feature in the forest, frequently consociated with fern-trees and *Fagus Cunninghamii* [= *Nothofagus cunninghamii*]. Common in Van Diemen's Land. (Mueller 1860-1862, p.24).

These two accounts leave little doubt that *A. moschatum* did occur in the Otways at the time of European settlement, although it was apparently rare. Unfortunately, no herbarium specimens from the Otways are known to exist. None are held at the National Herbarium of Victoria, the University of Melbourne (K. Wilson, pers. comm.), or in Britain at the Kew Herbarium or the British Museum (P. Short, pers. comm.).

For a number of reasons, it seems unlikely that Mueller's record would have been a mistake. Firstly, *A. moschatum* is a distinctive species, and Mueller, of all people, is hardly likely to have confused it with any other. Secondly, the locality note provides reasonably detailed information on habitat and abundance in the Otways; information which is unlikely to have been erroneously recalled by Mueller. Thirdly, Mueller was passionately interested in the biogeography of distinctive elements in the Australian flora, such as rainforest and alpine plants. Finally, a small population of *A. moschatum* still exists on King Island, 130 kilometres SSE of Cape Otway (J.H. Willis, pers. comm.).

If one assumes that these early records are not erroneous, then they clearly

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demonstrate that *A. moschatum* was present in the Otways at the time of European settlement. Presumably, it was exterminated by the indiscriminate clearing and burning that characterised early European land use in the region (Williams 1977, Brinkman and Farrell 1990). The tantalising question of course remains, why was *A. moschatum* rare, and why wasn't it common in the Otways, as in the Central Highlands and Gippsland?

Acknowledgements

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What Rotifer is that?

D. E. McInnes*

This is the question a pond-hunter often asks, but first, what is a pond-hunter? Well, a pond hunter is one of those persons who dips their pond-net into any pond or lake and sweeping it around makes a gathering of pond-life. This is carefully placed in jars and taken home for examination under a microscope.

The pond-weed is examined for attached forms and the water for free-swimmers. Most of the creatures may have been seen before but the pond-hunter is always looking for the specimen seen for the first time.

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Rotifers have always been a favourite with pond-hunters because of their amazingly different shapes and methods of living. Those fixed inside their tubes snare their prey with either wheel-like nets or outstretched nets of straight rays. Then there are the multitude of free-swimmers of all shapes and sizes. All have given many hours of pleasure when viewed under the microscope.

If this shows a rotifer never seen before the specimen will be isolated and given a good examination. Then comes the question What rotifer is that? Recently I saw a rotifer that I have never seen before.

My first move, as always, was to look up Ward and Whipple, 'Freshwater Biology'. This has always been the bible of pond-life for many years. My own copy came out in 1918, but there is a later edition, published in 1959 and both editions are in the FNCV library. The book is a reference for pond-life in North America, but the species are fairly comparable with those found in Australia. Another good, but smaller book is 'A Guide to the Study of Fresh-water Biology' by Needham and Needham, (1963).

The older Ward and Whipple identified my strange rotifer as *Apsilus*, but the 1959 edition called it *Cupelopagis*. Checking for further information in the library, I was fortunate to find a reference to Dr R. J. Shiel, a biologist at the Murray-Darling Freshwater Research Centre, Albury. He is the author/co-author of over fifty papers

on various aspects of freshwater biology, and in particular he and Dr Koste have written twenty-four papers describing Australian rotifers. So I wrote to him and he was able to send me information all about the *Cupelopagis* which had been written by Dr W. Koste, the German biologist who is known world-wide for his knowledge of rotifers, and is now 80 years old. Furthermore, Dr W. Koste and Dr Shiel are writing 'Rotifera from Australian Inland Waters', a publication that will probably then become the basic text for Australian rotifera, since their research updates the information available to Australian pond-hunters. Dr Shiel has donated the first seven parts to the FNCV library. A list of these works can be found at the end of the following article by Dr Shiel - Answer to 'What rotifer is that?'

Answer to 'What Rotifer is that?'

R. J. Shiel*

Walter Koste solved the problem of the interested Pond Hunter very neatly. For 20 years he has written regular articles about his favourite animals for his local naturalist/microscopist journal *Mikrokosmos* ('Microcosm'). These were titled 'Das Radertier Portrat' ('A rotifer portrait'), dealing with the peculiar habits of particular species of rotifer, on the diversity of species in a genus, and so on. About 30 of these small natural history papers were prepared between his larger monographs and classic 1000 page, 2 volume treatise on the rotifers of middle Europe, which was published in 1978.

What has all this effort produced? When Dr Koste saw his first Australian rotifers in 1976, there were about 250 named species known from Australian waters (there are more than 2000 rotifer species known globally). Many of these species had been named by early visitors to our shores, who compared them to familiar animals "back home", and often named them for the species they most

closely resembled. This is like calling an echidna a porcupine — they are superficially similar, but are not closely related. The widespread use of northern hemisphere taxonomic works such as Ward and Whipple's 'Freshwater Biology', as mentioned above, or Pennak's 'Freshwater Invertebrates of the United States' has further encouraged the spread of northern hemisphere names for animals which may be as distinctively Australian as kangaroos and koalas. 16 years, 3500 samples and 24 publications later, we now know about 700 rotifer species from Australia, with more than half the species in some genera apparently indigenous. There are very distinctive biogeographical associations in some areas, e.g. Kakadu, N.T., Tasmania's west coast dune lakes, southwest W.A. It is likely that less than half of the existing species have been described, and it is also probable that many have been lost already, unseen.

For the interested pond hunter, the task of finding out which rotifer lives in his neighbourhood pond or dam becomes a

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major task when 50-60 species may co-occur, with seasonal appearances of possibly 100-150 other species. The reason for this species richness is seen in the specialization of these small animals, most less than 0.5 mm. They occupy all available spaces in their 3-dimensional world — the more diverse that world is, the more spaces there are for them to occupy: herbivores floating in open water graze on small algae, bacterivores graze bacterial films from submerged leaves, omnivores burrow in sediment on the bottom to eat dead and decaying organic matter, carnivores prey on sessile or free-swimming rotifers or microcrustacea, and parasites live on or in various other aquatic plants and animals. Closely related species may partition their habitat spatially by feeding on something slightly bigger or smaller than do their 'cousins', or temporally by hatching at a different time of the year.

A general review of Australian rotifers, among other groups, is given by Bill Williams (1980) in 'Australian Freshwater Life' (Macmillan). To identify the level of family may be possible with the northern hemisphere works mentioned above, but to identify to genera or species, the keys of Walter Koste are required. Only about half of the planned Australian papers have been published, the others are in various stages of preparation. The published papers can be obtained from R.J. Shiel, and interested readers can be placed on a mailing list for the remainder as they are produced. Ultimately the group will be reviewed in the *Fauna of Australia* series (Australian Biology Resources Study, Canberra). Should there be sufficient interest, a small field guide to families and genera could be produced.

Now, you may guess that I have been avoiding the original question - to identify your rotifer is relatively simple if it has a lorica, a hard proteinaceous 'shell', into which it withdraws if threatened. Most common loricate rotifers in Victorian waters are the Brachionidae, particularly the genera *Brachionus* and *Keratella*, the Euchlanidae and the Mytilinidae, all readily identified from the patterning, spines, etc. of their lorica. Keys are available for most of these loricate families. The illoricate rotifers, those without a firm casing, present more of a problem. They are best studied alive to

determine their extended morphology, which is necessary to place them into family and genus. Preservation usually leaves a contracted blob and considerable frustration to the pond hunter. To determine species, it may be necessary to preserve and clear the rotifer to examine its specialized mouthparts — the *trophi* of rotifers appear to be species-specific. Since these are tiny structures, sometimes as small as 20 µm, oil immersion or scanning electron microscopy is necessary. Some of the illoricate family keys are already available, with the rest due in the next two years.

My answer at our present stage of understanding of these tiny animals is: identify them as far as you can using available literature, with due caution if it is not an Australian publication. If you can make permanent mounts, do so, or if you can make a sketch or have access to a microscope-mounted camera, take photographs. Failing all else, send your photograph, drawing, mounted slide, or original water sample to R.J. Shiel, P.O. Box 921, Albury 2640 to help answer the question!

References

Note that all parts of 'Rotifera from Australian Inland Waters' issued to date, are in the FNCV Library and are available to members of the Club, or an inquiry at the Municipal, TAFE or University Libraries will give information where the various parts may be seen.

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- VI (1990). Proalidae and Lindiida (Rotifera: Monogononta). *Transactions of the Royal Society of South Australia* **114**: 129-143.
- VII (1991). Notommatiidae (Rotifera: Monogononta). *Transactions of the Royal Society of South Australia* **115**: 111-159.
- VIII (1992). Trichocercidae (Rotifera: Monogononta). *Transactions of the Royal Society of South Australia* (in prep.).

Expansion of the Range of the Black Wallaby in Western Victoria

by P. R. Bird*

There is currently a curious expansion in the population of *Wallabia bicolor* (black or Swamp Wallaby) in western Victoria - an extension that has taken this species across cleared farmland and even into the city of Hamilton (Fig. 1).

The Swamp Wallaby known locally around Hamilton as black wallaby, occurs widely from northern Queensland through New South Wales to south-eastern and central parts of Victoria (Strahan 1983). In western Victoria it occurs in the Brisbane Ranges, is common in the Otways, and occurs further west along the coast at Naringal in the Ralph Illidge Sanctuary. The species once occurred in south-east South Australia, and in what is now the Lower Glenelg National Park, although Menkhurst and Beardsell (1982) consider comparatively recent reported sightings there as "doubtful". The Swamp Wallaby was first reported in the Grampians in 1979 (Bird 1981), although it was probably seen earlier by others but not recognised as significant. It is not known whether the wallaby had retained a presence there over a long period, or was a recent immigrant, possibly from the south coast. One route might be up the Glenelg river from the coastal border region - another route is via highways, or across farms, from Naringal. Tom Morgan of Ararat has seen the wallaby at Mt. Langighiran, and a road-kill further east near Trawalla in January 1992, suggesting another route from eastern Victoria through the central highlands.

The distinctive features of this wallaby are: a long black tail, black lower parts of legs and paws, orange or rufous-coloured chest and belly, rufous crown and lower parts of ears, black or dark grey face and forehead with paler fur on cheeks, grizzled grey-brown back and flanks, paler grey on the upper arms. The general impression,



Fig. 1. Location of Hamilton in relation to the Grampians National Park, Reproduced from the Department of Conservation and Environment.

particularly from a distance, is that of a dark-coloured wallaby. This contrasts with that of the Red-necked Wallaby (*Macropus rufogriseus*), where the impression is of a light-coloured animal. The distinctive features of the Red-necked Wallaby are: a rufous-coloured patch on the back of the neck and shoulders, rufous tinge to fur on the rump, white or pale grey chest and belly, body and tail darker grey, muzzle and paws black. These species are of similar mature size and are likely to occur over much the same range in Victoria and New South Wales; they have been well illustrated in colour plates (Gould 1973) and photographs (Strahan 1983).

I have given below a recent listing of sightings of Swamp Wallabies (and dark-coloured wallabies) near Hamilton in western Victoria, an area in which, apart from the Grampians, this species has either not before been recorded or reported.

In April 1983 I observed and photographed a large old male Black wallaby at Lake Surprise (Mt. Eccles National Park), shortly after sunrise. The animal was eating

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the leaves of *Rubus parvifolius* (Small-leaf Bramble) and moved away into the forest when it saw me. Allan Gould (for many years the ranger at the park) had not seen the species before and it was not listed for that area by Menkhorst and Beardsell (1982).

In October 1987 I surprised a Swamp Wallaby at the 860 ha Kanagulk Streamside reserve on the Glenelg River, north of Balmoral. The animal was sheltering in dense bracken along the river bank at the eastern end of the reserve. After breaking from cover beneath the small cliff on which I stood, it disappeared further down stream amongst tussocks and trees. I have also seen Red-necked Wallabies in the western part of this reserve, the Dundas Range, the Grampians, Heywood State forest and the small Pallisters reserve near Orford, but not on any other small reserve or on farmland away from forest.

Mr Laurie Kirkwood, a farmer to the west of the Mt. Napier State Park, observed a black wallaby at close quarters in January 1987, when travelling along a track in the middle of the forest. Mr Simon Gubbins of "Murroa", which adjoins the park on the north, also reported that in 1991 his dogs killed a small dark-coloured wallaby that wandered into the homestead area, close to the forest.

Others to report dark-coloured wallabies on their farms include Ms Elizabeth Fenton from "Larapinta" at Yulecart, on the Muddy Creek 12 km west of Hamilton. One animal was seen in a revegetation area on the farm early in 1991 and it, or another, has returned to the area in 1992. Others were first seen in 1989 on bush blocks off Chatsworth Rd, 5 km east of Hamilton, and these wallabies also appear to come and go. Trees and shrubs there are *Acacia mearnsii* (Black Wattle), *Bursaria spinosa* (Sweetbursaria), *A. paradoxa* (Hedge Wattle) and *Eucalyptus ovata* (Swamp Gum).

During the months of January-March 1992 dark-coloured wallabies have been seen at several locations in or near

Hamilton. One was seen at the Hamilton Community Parklands near North Boundary Rd, and in a garden along that road. They also appear to visit properties along Hensley Park Rd, and frequent a pine plantation nearby. Barry Wright (Department of Conservation and Environment, Hamilton) has also seen Swamp Wallabies at several locations in Hamilton, including the Grange Burn near Mt Napier Rd, and in Strachan St.

Rural fire brigades, when conducting burning-off operations, flushed a wallaby from the verge of the Glenelg Highway, a few kilometres east of Hamilton. Another was seen by Don Jowett of Hamilton early on 25 February 1992, some 35 km east of Hamilton on the Chatsworth Rd, near the intersection with the Dunkeld-Caramut Rd. This dark-coloured wallaby was feeding on new growth adjacent to tall unburnt *phalaris* near the fence. At least one black wallaby has been seen at different times at the Pastoral Research Institute, 10 km south of Hamilton. The wallaby rests in the shelterbelts and drinks from the stock watering troughs.

During the same period at least three dark-coloured wallabies have been killed on roads near Hamilton: on Coleraine Rd near its intersection with Nth Boundary Rd; on the Hamilton Highway near Tarrington; and on the Henty Highway between Violet Creek and Muddy Creek. The latter wallaby was struck on 7 February 1992 and reported to me by Ms Kay Aldridge of Hamilton. I collected and photographed the animal - a young male black wallaby of about ten kg.

I was also reminded by Les Marshall (Hamilton Parks and Gardens superintendent) that early one morning in 1990 a dark-coloured wallaby was found sheltering in the rear of a business premises in Brown St Hamilton - the animal was injured and may have been chased there by dogs. The young male wallaby was subsequently lodged with Red-necked Wallabies at the Hamilton Botanic gardens and made a good recovery. I observed this



Fig. 2. A captive Black Wallaby, *Wallabia bicolor* at the Hamilton botanic gardens.



Fig. 3. A captive Red-necked Wallaby, *Macropus rufogriseus* at the Hamilton botanic gardens.

wary black wallaby in April 1992 and, after several visits, was able to photograph it from a distance with a 400 mm telephoto lens. A photograph of it and companion Red-necked Wallabies accompany this report (Figs. 2 and 3).

Mrs Susan McInnes, a resident near the Bullawyn Rd in the Victoria Valley of the Grampians area, believes that Swamp Wallabies are now as widespread in the Grampians as the Red-necked Wallaby (although the total population does not seem to be high) and may be encountered throughout the length of the Grampians. I have seen one Swamp Wallaby on Mt. Abrupt and another in the Flat Rock-Hollow Mountain area; others have also seen them in different areas of the Grampians. Susan McInnes considers that many recent "sightings" of the Grampians puma may be attributed to a glimpse of a Swamp Wallaby darting across a track and vanishing into bushes - the wallabies long black tail is usually held straight out behind in flight, and the shape is similar to that of a puma's tail!

What a change in the status of the Swamp Wallaby in just over ten years - where did the wallabies come from? Susan McInnes has seen one moving along a

minor road off the Victoria Point Rd (between the Grampians and Hamilton), which perhaps indicates that the origin of the population around Hamilton is the Grampians. I have observed Eastern Grey Kangaroos (*Macropus giganteus*) travelling across farmland at least 10 km distant from the nearest forest, and presumably they could travel the required 25 km or so without much difficulty. Wallabies could certainly do so in stages, probably sheltering during the day in long grass on the roadside, but what has prompted the wallabies to spread from their more usual habitat? Perhaps there are studies of black wallabies which provide an explanation of such behaviour; if so, it would be interesting to know of them.

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- Strahan, R. (1983). 'The Australian Museum Complete Book of Australian Mammals'. (Angus and Robertson: London).

Threatened Species in Australia: A Select Bibliography

by K. P. Slattery and R. L. Wallis

Publishers: Deakin University, Rusden Campus (1991).

A4, 281 pages, r.r.p.\$A23 (softcover). Also available on floppy disc using INMAGIC software, \$A65. From Mr M. Holmes, Department of Science, Victoria College - Rusden Campus, Clayton, Victoria 3168.

Much of the concern for the Australian environment, and much of the developing methodology of, and setting priorities for, conservation, is orientated towards the wellbeing of species - both of particular plants and animals perceived as 'threatened' in some way, and for the symptoms they indicate of a more general conservation need. Many practicing conservationists develop their interest and commitment through knowledge of a particular taxonomic group of organisms and, whereas they may know the literature pertinent to 'their' group, much of the other species-orientated literature is likely to be relatively obscure, although it may be invaluable in revealing parallel examples of decline or conservation need, and in seeking persuasive argument for habitat reservation or management.

This book is a compilation of references on 'threatened species' in Australia, and is a remarkably complete and useful listing, with entries ranging from the very general (such as references to relevant species in published volumes of the 'Zoological Catalogue of Australia') to specific journal or report references to species. Journal titles are given in full and all references given, including newspaper articles, should be traceable easily. About 80 serial publications (listed in the introduction) have been scanned for titles for inclusion. Most of these are strictly Australian in coverage, although a few non-Australian based journals are included, and many references are recent. The period of scanning is not given, but some early 1991 references are included.

The book starts with a brief essay on extinction, and uses Ahern's (1982) categorisation to define 'threatened', so that readers accustomed to the more widely used IUCN categories (which are not included here) will need to note the

differences. However, criteria for inclusion of a given species in this Bibliography are not made clear and, in general, 'threatened' seems to cover taxa about which concern has been expressed in other publications, and the compilers have - wisely - not ventured to comment further on the status of taxa included. The introduction also includes alphabetical lists of 'subject headings' and 'scientific names', but there is no systematic listing - an omission I found surprising and which would markedly increase the efficiency with which the book could be used. Neither of the above lists is indexed to page numbers in the bulk of the book. However, the entries are arranged in alphabetical order of common names (where these exist) or scientific names (where no common name is available), so that the book starts with Abbott's Booby and finishes with *Zieria* spp. Interspersed through species/genus listings are headings such as 'general', 'legislation/policy' and other thematic categories, and more than 3000 references cover well over 400 taxa.

The coverage is good, and any concerned conservationist will benefit from this volume. I hope that the authors will indeed provide 'updates' at intervals, as stated that they plan to do. This book deserves wide use and should be made available in any library used by students or research workers in conservation, wildlife biology, ecology and similar topics. The floppy disc version, which I have not seen, is an excellent and innovative idea, and the authors should be congratulated on a job very well done, and which will surely be of lasting value.

T.R. New, Department of Zoology, La Trobe University, Bundoora, Vic. 3083.

References

Ahern, L.D. (1982). Threatened wildlife in Victoria and issues related to its conservation. *Fisheries and Wildlife Papers, Victoria*, No. 27.

The Concise Oxford Dictionary of Zoology

Edited by Michael Allaby

Publishers: *Oxford University Press (1991)*.

R.r.p. \$A39.95 (hardcover).

The technical and semi-technical vocabulary of a science can prove to be a barrier to understanding the discipline, and overcoming that barrier is a theme central to learning any science which depends on precise and accurate communication. Scientific dictionaries abound, and Michael Allaby has now added another to the several he has compiled in the last few years. This 'Concise Oxford Dictionary of Zoology' is aimed at the student and non-specialist - a readership deserving of the greatest respect from authors and publishers of books of the genre. Some 6000 terms are included, comprising names of taxa and many functional and conceptual aspects of zoology and ecology. Names of a few eminent biologists, with brief biographical notes, are also included.

Compiling any work of this sort is a brave task, as it is inevitable that the editor must enter areas beyond his personal expertise. It may be equally invidious to criticise it, as some criticisms are likely to reflect the reviewer's (equally personal) bias. I suggest that a dictionary of this kind needs to fulfil three main roles: to be accurate and comprehensible; not to have major omissions or, at least, to be consistent in its level of treatment; and to provide derivative explanation of the terms used, as much of the readership is unlikely to be familiar with Latin or Greek, the languages from which much scientific vocabulary is derived. Unlike, for example, earlier editions of 'Henderson's Dictionary of Biological Terms', the third of these roles is almost wholly lacking, reducing the use of this book to people interested in 'words'. Inexplicably, the derivation of the insect order Trichoptera is given, but this is a rare exception.

I used a selection of entries dealing with the insects to evaluate the other worths of this Dictionary, and encountered a number

of problems, which I exemplify below. Personal bias first: the order Psocoptera (and its various synonyms and common names, such as 'booklouse') does not occur. 'Plecoptera' (stoneflies) and 'Embioptera' (webspinners) are also omitted, though some included orders (such as Grylloblattodea and Zoraptera) are likely to be sought less by users. There are also inconsistencies in level of treatment: however admirable from some points of view, it seems unnecessary to enter families of parasitic lice (Phthiraptera) and dragonflies (Odonata) whilst completely ignoring other whole orders; to enter families of Hymenoptera, but not superfamilies; and to provide separate suborder entries for some orders but not others (Thysanoptera). Entry of families seems rather random: in the order Neuroptera, Chrysopidae (green lacewings) is included, while Hemerobiidae (brown lacewings) is not. Common names abound but many are not explained well. Under 'butterflies' or 'moths' we are told 'see Lepidoptera'. 'Lepidoptera' starts off with 'moths and butterflies', but nowhere in that entry are we told what criteria define or delimit each of these. Likewise, 'owlflies' notes, 'see Neuroptera', where they are listed as a component of the order, with no diagnostic information, and there is no entry for the family to which they belong (Ascalaphidae). At best, the taxonomic coverage is uneven; at worst it is sloppy and lazily assembled. In fairness, Allaby notes in his Preface that only 'in most cases' are extant groups treated to ordinal level, but the rationale for inclusion or neglect is not specified.

Many explanations of terms included are admirably concise and accurate. However, editing and preparation of a work of this sort should be meticulous. It is not.

Several categories of error occur: spelling

e.g. 'laviposition' without the 'r' introduces an unsuspectedly violent aspect to live birth in insects; grammar e.g. 'exuvium' is not admitted as a term by Torre-Bueno and other authorities and the only proper term for the cast remains of arthropods is 'exuviae', whether singular or plural; explanation e.g. 'puparium' is not 'a pupa formed from the exoskeleton of the final instar larva' but, rather, the exoskeleton of that larva within which the pupa is formed. Lastly 'non-sequiturs' e.g. 'retinaculum' is correctly explained as a structure involved in linking fore and hind wings, but 'see *Collembola*' is interposed between this explanation and 'frenulum' when the retinaculum of *Collembola* is a very different structure. In many entries where disparate meanings occur for a term these are listed clearly under separate numbers: why not here?

Individually, these (and other) examples may seem carping. Collectively, though, they diminish the value of this Dictionary as an educational or instructional tool, and introduce frustrations. There is much good about the book and much can be learned from it. It is well bound and printed, and looks good on the shelf. But dictionaries must be more than decorative, and this one has sufficient failings for me to have reservations about recommending it highly.

T.R. New, *Department of Zoology, La Trobe University, Bundoora, Vic. 3083.*

References

Holmes, S. (1979-85). 'Henderson's Dictionary of Biological Terms', 9th ed. (Longman: London and New York.)
Nichols, S.W. (compiler) (1989). 'The Torre-Bueno Glossary of Entomology'. Rev. ed. (New York Entomological Society: New York.)

Beach Plants of South Eastern Australia

by Roger Carolin and Peter Clarke

Publishers: Sainty and Associates (1991).

119 pages, colour, soft cover, r.r.p. \$18.90.

The stunning cover photograph of this new publication sets the tone for the rest of the book. More than 140 species of beach and foredune plant are illustrated. The majority of these are excellent colour plates.

The introduction of the book includes brief notes on the beach environment, encompassing soils, climate and ocean influences. Likewise there are brief notes on the plant communities of the strandline, foredune and forests beyond. So it covers both coast and near-coastal plants.

The arrangement of the plants into families allows the book to be used as an identification guide. Users can quickly identify a flowering specimen if they are familiar with family groups, or have a more leisurely leaf through the photos if not

familiar with the families. Likewise the consistent use of both common and scientific names helps to make it more accessible to a general audience.

My only criticism of the book - and a not insignificant one - is its size and dimensions. At 200 by 245 mm it allows for large plates and an attractive layout. However, a soft cover book of this size will be quickly damaged in a day-pack, which is where this book belongs and one of half this size would be more suitable.

This one criticism aside, I would certainly recommend 'Beach Plants of South Eastern Australia' to anyone who spends some time exploring the beautiful coastlines of southeast Australia.

I'll certainly be buying a copy.

Tim Offor

FNCV Library

As from 2 June 1992 the Club Library will be open on **Tuesday and Wednesday from 11 am to 2 pm**. It will continue to be open before General Meetings from 7.15 pm to 7.55 pm. So far, the Botany and Microscopical Groups have provided people to open the library on their meeting nights. I would be glad to hear from any volunteers to do the same for the Fauna Survey and Geology Groups, and also from anyone interested in helping in the library during the day. You may phone the FNCV office on (03) 650 8661 or contact me direct on (054) 28 4097.

Club membership cards will be issued to currently financial members wishing to use the library, which must be presented when borrowing books and periodicals. The loan period is two months. If you wish to keep books for another two months it would greatly assist the library staff if you would renew your loan.

The library is located in a small building behind the Astronomer's Residence (next door to Governor La Trobe's Cottage).

The following books have been added to the library:

Birkhead, M. and T. (1989). 'The survival factor'. (Boxtree: London.)

Carolin, R. and Clarke, P. (1991). 'Beach plants of south-east Australia'. (Sainty: Potts Point N.S.W.)

Kingsford, R. (1991). 'Australian water birds'. (Kangaroo: Kenthurst, N.S.W.)

Lindenmayer, D., Tanton, M. and Norton, T. (1992). Identification of the forest habitats of possums and gliders in Central Victoria. (Panther: Fyshwick A.C.T.)

Newton, M.E. (1989). A practical guide to bryophyte chromosomes. (British Bryological Society: Cardiff.)

Robin, L. (1991). Building a forest conscience: an historical portrait of the Natural Resources Conservation League of Victoria 1944-1990. (NRCL: Springvale South, Vic.).

The library also receives the following periodicals:

The Australian Birdwatcher.

ACF newsletter.

Australian Geographic.

Australian Journal of Botany.

Australian Plants.

Australian Wildlife Research.

Bulletin of the American Museum of Natural History.

Country-side.

The Emu.

Environment Victoria.

Fieldiana - Botany.

Fieldiana - Geology.

Fieldiana - Zoology.

Forest Focus.

Geelong Naturalist.

Greenprint.

Habitat.

Helictite.

Heritage newsletter.

Indigenotes.

I.U.C.N. Bulletin.

Journal of the Adelaide Botanic Gardens.

Journal of the Malacological Society of Australia.

Journal of the Royal Society of New Zealand.

Journal of the Royal Society of Western Australia.

Junior Naturalist (Hawthorn Junior FNC)

Kew Bulletin.

Marine News newsletter.

Memoirs of the Museum of Victoria.

Memoirs of the Queensland Museum.

Microscopy.

Muelleria.

Occasional Papers of the Museum of Victoria.

Pacific Science.

Papers and Proceedings of the Royal Society of Tasmania.

Parkwatch.

Proceedings of the Linnaean Society of New South Wales.

Books

Proceedings of the Royal Society of New Zealand.	South Australian Naturalist.
Proceedings of the Royal Society of Queensland.	Tasmanian Naturalist.
Proceedings of the Royal Society of Victoria.	Trees and Natural Resources.
Publications in Zoology (University of California).	University of Queensland. Dept. of Geology - Papers.
Quarterly Notes of the Geological Survey of New South Wales.	Victoria University of Wellington. Zoology publications.
Queensland Naturalist.	V.N.P.A. newsletter.
Records of the Auckland Institute and Museum.	Whirrakee.
Records of the Australian Museum.	Western Australian Naturalist.
Records of the Canterbury Museum.	Wildlife Australia.
Records of the Queen Victoria Museum, Launceston.	Wingspan.
Records of the South Australian Museum.	World Birdwatch.

Sheila Houghton
Hon. Librarian

We are hoping that a member from each group would be able to look through the most recent journals and note any articles that might be of interest to their members.

Errata

Yarra Pigmy Perch, *The Victorian Naturalist* 109 (2), 1992.

Para 3 should read:

line 13 "and west of the Yarra"

line 16 "in eastern Victoria"

The editorial group wish to apologise for these mistakes.

River of Sand and Channels of Clay

A talk given by Helen Aston to the FNCV Monday, May 11, 1992. Helen spent two weeks in May/June 1991 travelling with naturalists on a camping trip run by "Wild Country Safaris". The trip took them down the Hay River in the SE corner of the Simpson Desert, Northern Territory, then into the channel country of the Georgina area in SW Queensland, and ended in the rocky hill county of Dajarra/Mt Isa. The talk commenced with a brief outline of the history of exploration in the eastern Simpson Desert and continued into an account, with slides, of the trip itself.

Eastern Simpson Desert - historical exploration

Captain Charles Sturt was the first white man to see and enter the Simpson Desert, entering from the Queensland side in 1845 but being forced to turn back. From 1878-1881 C. Winnecke and N.V. Barclay explored the northern fringe. Following this, Winnecke made a major attempt in 1883, to examine the Desert itself, traversing most of the upper course of the Hay River which he discovered and named. Plants collected by Winnecke were identified by Baron von Mueller. Between 1883 and 1886 the Qld/NT border was surveyed, commencing at Poeppel's Corner which was named after the surveyor who commenced the work.

E.A. Colson is credited with being the first white man to actually cross the Simpson Desert. In 1936, with an aboriginal boy and using camels, he made a west to east crossing to Birdsville on a line not far north of the 26th parallel. In 1939, C.T. Madigan organised the first party of scientists (including the botanist R.L. Crocker) to cross the Desert, conducting scientific investigations as they went. On camels, they crossed west to east from Andado Station, NT, to the Mulligan River, Qld. Madigan's party was the first to reach the lower Hay River since Winnecke's exploration of 1883, and considered it "like a dead river valley", without any sign of water having penetrated that far. Between the Hale and the Hay Rivers Madigan crossed 500 sandridges, measuring heights of the latter

at 80 feet. It was Madigan who named the Simpson Desert.

Since the 1960's a good deal of scientific work has been undertaken in the area, and much has been published. 'Land Systems of the Simpson Desert Region' by R. Purdie (publ. CSIRO, 1984) gives detailed vegetation studies.

The trip of 1991

The trip commenced and ended at Mt Isa, going first through Urandangie along the Plenty Highway to "Tarlton Downs" Station. Here, at Junction Bore, the Arthur and Marshall Rivers join to form the Hay River. The Hay is the easternmost of four rivers (including the Hale and the Plenty) which penetrate the Simpson from its north side and run in more or less straight lines between the parallel dunes until simply fading out. With every expectation that it would be a typically dry "river of sand" expedition members were delighted to find larger and larger pools of water along it as they progressed southwards. These were the results of heavy flooding in Central Australia about 3 months previously. The largest pool, some hundred or more metres long was sited where the outflow from Lake Caroline joins the Hay. Lake Caroline itself was dry, but even so, its enormous flat expanse, several kilometres in diameter, was spectacular.

A crossing from the Hay near Lake Caroline to No 6 Bore on the Plenty River took the party east to west over 58 sandridges, the 57th, some 15 metres high, demanding that some air be let out of the tyres of one of the two big 4-wheel drive

trucks in order to effect a crossing. Thence via "Atula" station to Boulia township and south to Four Mile Waterhole, one of the many "channels of clay" the party experienced in the Georgina area. Heading north, near Dajarra, a scenic amphitheatre surrounded by tall rocky outcrops was a good indication of the hilly topography towards Mt Isa.

Botany

The flora of the whole Simpson Desert is comprised of almost 800 species of high plants from 75 families. Just four families, Poaceae (grasses), Chenopodiaceae (chenopods), Asteraceae (daisies) and Fabaceae (peas), contain 44% of the total flora. Over half (57%) of the species present are ephemerals or short-lived perennials which are usually absent during dry periods.

Slides showed the Hay River fringed with River Red Gum (*Eucalyptus camaldulensis*) and with scattered Ghost Gum (*E. papuana*), its damp areas supporting new green growth of grasses and forbs such as *Aristida* with its 3-awned fruits all embedded and germinating in the soil, Perennial Caltrop *Tribulus occidentalis* with large tough spiny fruits and yellow flowers and the introduced Pie Melon *Citrullus lanatus* with fruits probably 30 cm long, the seeds of which are eaten by cockatoos. The sundew *Drosera indica* was frequent and flowering in saturated parts of the river bed and had captured large butterflies. Sandridges typically had the Sandhill Canegrass *Zygochloa paradoxa* and "spinifex" *Triodia*, with scattered bloodwoods *Eucalyptus terminalis*. Channels were dominated by fringing Coolibah "*Eucalyptus microtheca*" and Lignum "*Muehlenbeckia florulenta*", with the plains around them bearing tall shrubs of the Georgina Gidgee *Acacia georginae*.

Birds

The bird slides interspersed throughout the talk were kindly lent by the slide library of the Bird Observers Club of Australia.

They were used when speaking of trip highlights such as the Flock Pigeon, seen near Urandangie doing the V-glide courtship flight and also seen at drinking spots elsewhere; raptors such as the Spotted Harrier and Black Falcon; Budgerigar, Cockatiel, Zebra Finch and waterbirds such as Black-fronted Plover, Pacific and White-faced Heron and Straw-necked Ibis along the Hay taking advantage of the water to penetrate such an otherwise dry region; 80 Diamond Dove drinking and perching together at a pool along the Marshall River; Little Button-quail often flushed from the dunes; Pied Butcher-bird taking one of the numerous burrowing frogs which emerged one rainy night along the Hay; Inland Dotterel and banded Lapwing on claypans near Lake Caroline; Spinifex Pigeon escaping from the swoop of a Collared Sparrowhawk; the great leap in waterbird numbers and species once the channel country was entered; Fairy Martin nests in a natural setting around the trunk of a big gnarled tree on a Georgina channel; and others. A bird chart of the trip records was available for perusal at the end of the talk.

Other Fauna

Dingos were seen and heard in the desert, and gave a splendid vocal performance one evening. Wild camels were about, particularly in the vicinity of the pools of the Hay. Shoals of small fish, were common in pools of the Hay and were stalked by the white-faced Heron.

The President, Arthur Farnworth, thanked Helen for her well-prepared address and detailed commentary, supported by excellent photography. It was clear she was a keen, dedicated and enthusiastic observer and this was confirmed by the acclamation from the 50 plus interested members and friends present.

Noel Schleiger

Victorian Nat.

Box & Ironbark Woodland Conservation

**A conference organised by the Victorian National Parks Association
at Benalla, north-eastern Victoria, August 24th & 25th 1992.**

The Victorian National Parks Association is hosting a conference on the inland forests and grassy woodlands extending from northern New South Wales to western Victoria. The Box and Ironbark woodlands of eastern Australia have been mostly cleared and the remnants continue to be degraded by poor management. Conservation management of these woodlands suffers from both a lack of basic ecological information and insufficient public and government interest.

This important conference will bring together all people interested in preventing further degradation of these woodlands - naturalists, biologists, farmers, foresters, conservationists, land managers and others, to hear the latest information and to discuss what is required to conserve the plants and animals of the Box and Ironbark country.

Some speakers and topics that will be included are:

- Fauna conservation in Box and Ironbark Forests - a landscape approach (Dr Andrew Bennett, Arthur Rylah Institute of Environmental Research, Department of Conservation & Environment, Victoria).
- Conservation of remnant vegetation in the New South Wales Box and Ironbark lands (Mr Dominic Sivertsen, NSW National Parks & Wildlife Service).
- Making it happen: Strategies for long term change (Ms Margaret Blakers, Victorian Office of the Environment).
- Socio-ecology: Extension programs needed to conserve remnant woodland (Dr David Goldney, Charles Sturt University, NSW).
- Requirements of birds and mammals in Ironbark forests (Mr Barry Traill, Monash University).

A field trip through the district will be held on day two, with speakers talking on-site.

Cost:

Public land managers/biologists	\$40.00
Others	\$25.00
Concession	\$15.00

(Reduced rates available for single day registration)

Further Information

Further details of the programme, and accommodation and transport details are available from the VNPA.

Contact: Charles Sherwin, VNPA, 10 Parliament Place, East Melbourne, 3002.
Phone (03) 650 8296, Fax (03) 654 6843.

The Field Naturalists Club of Victoria

In which is incorporated the Microscopical Society of Victoria

Established 1880

Registered Office: FNCV, c/- National Herbarium, Birdwood Avenue, South Yarra, 3141, 650 8661.

OBJECTS: To stimulate interest in natural history and to preserve
and protect Australian fauna and flora.

Members include beginners as well as experienced naturalists.

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His Excellency, The Honourable Richard E McGarvie, The Governor of Victoria.

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Joint Concessional.....	\$27
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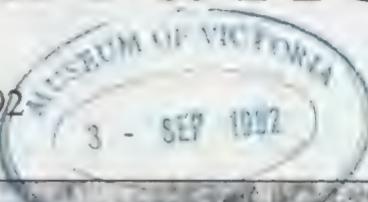
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FNCV Calendar of Activities

September	
Tues 1	Fauna Survey Group Meeting. The Fire Ecology of Small Mammals — Barbara Wilson. Herbarium Hall 8 p.m.
Thurs 3	Botany Group Meeting. Rare Native Plants and their Management in Victoria — Simon Cropper. Herbarium Hall 8 p.m.
Sun 6	General FNCV Meeting. Hosted by the Microscopy Group. Three Hundred Years of Microscopes. Herbarium Hall 2-5 p.m.
Sun 6	General FNCV Excursion. Orchids near the City. Warrandyte area. Leader David Cameron. Contact Dorothy Mahler, 850 9379 or 435 8408.
Sat 12	Fauna Survey Group Field Survey. Leadbeaters Possum Survey. Contact Ray Gibson, 874 4408.
Thurs 24	Fauna Survey Group Field Survey. Jilpanger. — Sun 2 Scrub Flora and Fauna Survey. Contact Lawrie Conole, (052) 294 037.
Sat 26	Botany Group Excursion. French Island. Leader Alan Chandler. Contact Joan Harry, 850 1347.
October	
Sun 4	General FNCV Excursion. Orchids at Moorooduc Quarry and Langwarrin Flora and Fauna Reserve. Leader Anne Read. Contact Dorothy Mahler, 850 9379 or 435 8408.
Tues 6	Fauna Survey Group Meeting. Out on a Limb: Conservation of the Brush-tailed Phascogale in Victoria — Tod Soderguist. Herbarium Hall 8 p.m.
Thurs 8	Botany Group Meeting. The Natural History of Somerset (UK) — Win Bennett. Herbarium Hall 8 p.m.
Mon 12	General FNCV Meeting. The Greening of Australia — Michaela Holyroyd. Herbarium Hall 8 p.m.
Sat 17	Fauna Survey Group Field Survey. Leadbeaters Possum Survey. Contact Ray Gibson 874 4408.
Wed 21	Microscopy Group Meeting. Desmids under the Microscope. Astronomer's Residence 8 p.m.
Sat 24	Botany Group Excursion. Flora of the Gembrook Hills. Leaders Hilary Weatherhead and Andrew Paget. Contact Joan Harry, 850 1347.
Sun 25-Sat 31	Annual FNCV Camp. Spring in the Grampians. Six day field trip. Contact Dorothy Mahler, 850 9379 or 435 8408.
Tues 27	Fauna Survey Group Meeting. The Management of Endangered Species — Peter Brown. Herbarium Hall 8 p.m.
Sat 31-Tues Nov. 3	Fauna Survey Group Field Survey. Wilsons Promontory (post-fire ecology study). Contact Anne Casey, 379 1611.

The Victorian Naturalist



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Assistant Editors: Ed and Pat Grey

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*Cover Photo: Watchbed Creek, Bogong High Plains, Summer 1988/89,
by Michael D. Howes.*

Editorial

A special issue on vegetation corridors in Victoria

The recognition of the value of vegetation corridors is growing rapidly as reflected in publications such as *Nature Conservation 2: The Role of Corridors* (reviewed this issue), VICROADS Roadside Management Plan¹ which is a marvellous hands-on publication on how to manage and revegetate corridors, the green web concept² of Neil Lawrence and the Victorian Farmers Federation, and Roland Breckwoldt's *Living Corridors*³. The protection of these remnants and their enhancement by revegetation and weed management is a key tool in addressing land degradation in Australia. These green veins provide habitat for wildlife, may be 'the last stand' for rare species, provide a seed resource of local material for revegetating adjacent land and are clues to what the vegetation has been in the past. Lessons such as which species grew where and when seedlings are recruited can be learnt from observing these remnants.

Corridors were set up to be used as conduits for stock, transport and other services. The local vegetation may now be completely removed, or altered from its former self. But vegetation is dynamic.

Many factors that pressure corridors, such as open edges allowing weed invasion or wind damage, changed drainage from the 'barrier' effect of roads or rail, or mistiming a disturbance by well-meaning management, such as cool burns in spring when the flora is setting seed reducing the seed load on a site. The issues can be very sensitive. In some areas of western Victoria a shire implemented a spray program to remove vegetation that was seen as a fire hazard. The program removed many grassland verges which have been replaced by weeds that produce a greater amount of fuel in summer, posing a greater fire risk. In contrast, in other grassland areas on the western plains of Victoria, the farmers slash and burn in late summer thus maintaining diverse grasslands.

Corridors will function as links, resources and habitat if we learn to manage in the naturally occurring windows of opportunity. This may mean leaving the corridor alone. In low rainfall areas, low nutrients and low disturbance may be the best defence against weeds. Or burning/slashing when seed set is finished. Recognising just what is native vegetation and when it sets seed depends on us gathering more information and having that information at hand for those that have to make the on-ground decisions.

The new program of VICROADS to train their staff in recognition of native vegetation, the VICROADS Roadside Management Guide, the seed collecting and sensitive pruning activities of shire work crews, and plantings by landcare and farm tree groups are examples of how we are learning to work with, not against, corridors in Victoria.

Robyn Watson

¹ Available from VICROADS Bookshop, 60 Denmark St, Kew, 3101, \$10.00.

² Published as a pamphlet and available from Greg King, VFF, Farrer House, 24-48 Collins St, Melbourne, 3000.

³ Available from Greening Australia offices, \$17.95.

Restoring Connectivity to Fragmented Landscapes: Does Roadside Vegetation Have a Role?

Andrew F. Bennett*

Habitat fragmentation and isolation — a problem for wildlife populations

Fragmentation and isolation of natural habitats is a major issue confronting wildlife conservation in Australia and throughout the world (Saunders *et al.* 1991). In Australia, the greatest loss and fragmentation of vegetation has occurred in rural areas such as the plains of western and northern Victoria, the inland slopes and plains of New South Wales, southern South Australia, and the wheatbelt region of Western Australia. In these areas, natural vegetation persists as a mosaic of scattered patches and strips, often neglected and degraded, in a vast 'sea' of cleared farmland.

A fundamental consequence for animals of the fragmentation and isolation of their habitats is a change in the connectivity of the landscape (Merriam 1984), which determines the ability of an animal to move through the landscape. Movement is a fundamental feature of animal life. Animals move within and between habitats on a daily or seasonal basis, to ensure access to resources such as food and breeding sites. Common movements include: daily foraging excursions; dispersal movements involving interchange between adjacent populations; seasonal or nomadic movements to use temporally and spatially fluctuating food resources; and long-distance migratory movements. Isolation by inhospitable environments (e.g. cleared farm paddocks for forest-dependant fauna) can limit or prevent these movements.

Habitat isolation and the consequent reduction in landscape connectivity can lead to the decline and eventual extinction of local populations, especially for those that are small in size. Small, isolated

populations are particularly vulnerable to random variation in the environment (e.g. food supply, climate), population parameters (e.g. birth and death rates) and genetic processes; and to natural catastrophes such as wildfires or floods (e.g. Shaffer 1981; Clark *et al.* 1991). There may also be additional pressures from surrounding altered environments, such as the intrusion of predators (e.g. Fox *Vulpes vulpes*, Cat *Felis catus*), or habitat changes from the influx of agricultural fertilisers and exotic weed species. Saunders (1989), for example, documented the extinction of three species of birds between 1975 and 1988 from an isolated 81 ha remnant in the wheatbelt of Western Australia. He also described the district-wide decline of many species of birds, of which 15 are believed to be locally extinct, over the last 80 years in the Kellerberrin district.

Restoring connectivity to fragmented landscapes

Practical measures that enhance connectivity within fragmented landscapes will reduce the detrimental effects of isolation, and improve the conservation status of wildlife. It is useful at this point to recognise two main components of connectivity. *Structural connectivity* refers to the spatial continuity of habitats in the landscape and is influenced by factors such as the distance between habitats, and the number and length of gaps in linkages. *Functional connectivity* refers to the ability of an animal to move between two habitats. Such movement depends not only on the continuity of the habitat, but also on the behaviour of the species, the distance it can move, and its response to the habitats through which it must move.

The most effective way to restore connectivity is to replace those habitats that have been cleared so that the overall

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habitat is restored in size and continuity. However, this is not always practical as there are usually a number of competing demands for land use. Alternatively, a portion of the original habitat can be retained, or restored, as a corridor that provides a continuous (or near continuous) link between otherwise isolated populations. Corridors may comprise linear strips, or a combination of strips and patches of habitat. In recent years, there has been a growing interest in the concept of corridors as a conservation measure, and their potential to restore connectivity to fragmented landscapes (e.g. Bennett 1990a; Saunders and Hobbs 1991).

Thirdly, where it is not possible to have a continuous link, patches and strips of remnant vegetation can form a series of discontinuous 'stepping stones' of suitable habitat. Stepping stones may restore effective connectivity for species with high mobility that are able to move across the intervening habitats (e.g. some birds, bats, large mammals). For example, Date *et al.* (1991) suggested that frugivorous pigeons in northern New South Wales were able to use stepping stone habitats of remnant and exotic vegetation as pathways for seasonal movements between large areas of rainforest.

Roadsides and the restoration of connectivity

Roadside vegetation has great potential as a system of corridors or stepping stones to maintain and restore connectivity through many rural areas of southern Australia. The length of roads and the area occupied by road systems is immense. In Australia in 1976, there were some 866,000 km of roads (Lay 1984). In Victoria, the 159,500 km of road reserve (Lay 1984) occupy some 2.5% of the State (Land Conservation Council 1988) approximately 567,000 ha or more than 10 times the size of Wilson's Promontory National Park. Obviously, much of this area comprises road surfaces used for transportation, but in many parts of Australia roadsides support long strips of

remnant natural vegetation. Roadside vegetation may vary from some 5 - 200 m in width (generally less than 40 m), and support forest, woodland, shrubland or grassland vegetation, characteristic of the local area and environment. Roadside vegetation forms linkages between many remnant areas (e.g. Bennett 1988; Saunders and de Rebeira 1991). Its potential connectivity is further enhanced by the network structure of road systems, often in the form of regular rectangular grids.

Travelling Stock Reserves, originally set aside as a network of stock routes for the movement of sheep or cattle (Anon 1983), are wide road reserves that often support remnant natural vegetation. Hibberd and Soutberg (1991) illustrate the extent of the network of stock reserves throughout New South Wales and Anon. (1983) summarises the conservation values of one reserve in South Australia, a 10 km section 400 m in width, which is now reserved as Ridley Conservation Park.

There is substantial evidence for the use of roadside vegetation in Australia as a habitat for a wide range of animals (e.g. Middleton 1980; Krohn 1981; Arnold *et al.* 1987; Newbey and Newbey 1987; Bennett 1988; Arnold and Weeldenburg 1990; Cale 1990; Keals and Major 1991; Lynch and Saunders 1991). Frequently, the species that occur on roadsides are locally common, but rare species also use these linear strips (e.g. Lynch and Saunders 1991). For example, in northern Victoria three species regarded as threatened in the State, the Grey-crowned Babbler (*Pomatostomus temporalis*), Brush-tailed Phascogale (*Phascogale tapoatafa*) and Squirrel Glider (*Petaurus norfolkensis*), are resident in roadside woodlands having suitable habitat. Indeed, roadside vegetation is now the major habitat for populations of the Grey-crowned Babbler in Victoria.

It can reasonably be proposed that where roadsides provide a continuous link between two habitats and populations of animals are resident along the roadside vegetation, the roadside is providing



Roadside vegetation along the Violet Town — Nalinga road provides habitat for the threatened Grey-crowned Babbler.

effective connectivity between the two remnants for those species. However, there is also a clear need for empirical evidence documenting and demonstrating the movement of wildlife along roadside corridors. Data describing such movements are difficult to obtain and may be anecdotal. The following examples are presented to illustrate different types of movements that roadside vegetation may facilitate in Australia. Examples of the use of roads and roadsides by wildlife in other countries have been reviewed by Bennett (1991).

(i) Daily or regular movements

Mobile species that utilise two or more different habitats on a regular basis, may use roadside vegetation as a movement pathway when these habitats have become isolated. For example, roadsides are used by some birds to move between nesting and foraging habitats in fragmented landscapes. The Superb Parrot (*Polytelis swainsonii*) uses forested roadsides as pathways to move from nesting areas in Red Gum forest in Barmah State Forest to foraging sites in remnant woodlands amongst nearby farmland (Webster 1988, 1992). These parrots fly in swift direct flight just outside or above the vegetated corridor (pers. observ.). Yellow Rosellas (*Platycercus elegans*) and Red-rumped Parrots (*Psephotus haematonotus*) are also

frequently seen flying along such roadside pathways. In Western Australia, Saunders (1980) and Saunders and Ingram (1987) noted the importance of roadside vegetation as links between nesting and feeding areas for Carnaby's Cockatoo (*Calyptorhynchus funereus latirostris*). They attributed the decline and local extinction of one breeding population, in part to the poor quality of linkages between nesting and foraging areas in that locality.

Western Grey Kangaroos (*Macropus fuliginosus*) were reported to use roadside vegetation as a pathway to foraging areas in farmland at Kellerberrin, Western Australia (Arnold *et al.* 1991). In Victoria, forest bats can frequently be seen flying and foraging at night along roadside corridors extending from remnant forests in farmland (pers. observ.).

In addition, the many species that live within roadside vegetation also make regular movements along the roadside to forage, find shelter and for social interaction with other animals.

(ii) Movement between two habitats or populations

Movements between disjunct populations have high conservation value when they allow interchange of animals that otherwise would not occur. Such movements can supplement a population that is declining, introduce new genetic variation, or assist a species to recolonise a habitat should local extinction occur.

Dispersal between populations can occur when young animals at independence disperse from their natal home range or nest area to a new location with suitable habitat. For example, Suckling (1984) studied a population of Sugar Gliders (*Petaurus breviceps*) inhabiting forest remnants amongst farmland in Gippsland, Victoria, and found that dispersal occurred at approximately 10-12 months of age. All recorded dispersal movements in this population involved animals moving along roadside vegetation for distances of up to 1.9 km. Three other arboreal mammals,

Common Brushtail Possum (*Trichosurus vulpecula*), Common Ringtail Possum (*Pseudocheirus peregrinus*) and Feathertail Glider (*Acrobates pygmaeus*), were present in the roadside vegetation and may also have used it for similar movements.

In western Victoria, Bennett (1990b) recorded dispersal movements of the Long-nosed Potoroo (*Potorous tridactylus*) and Bush Rat (*Rattus fuscipes*), that involved roadside vegetation as a pathway between forest remnants. The regular occurrence and movements of four other species of small mammals in roadside vegetation suggested a similar use of roadsides as pathways for dispersal. Arnold *et al.* (1991) identified and mapped vegetated roadside links apparently used by the Western Grey Kangaroo and Euro (*Macropus robustus*) for movement between remnant woodlands at Kellerberrin. However, they pointed out that these kangaroos are also able to move between remnants across farmland.

A long-term banding study of birds in remnant patches and roadside vegetation at Kellerberrin (Saunders and de Rebeira 1991) is beginning to reveal movements of birds through the landscape. Species dependant on remnant vegetation have been netted in road verges, and recorded movements of such individuals between remnants are believed to have followed roadside corridors. Cale (1990) interpreted temporal changes in the number of Red-capped Robins (*Petroica goodenovii*) on road reserves at Kellerberrin as evidence that this species was using roadsides for dispersal. The greatest number of individuals were present prior to the breeding season, and the majority of these were solitary females and juvenile males.

(iii) Seasonal movements

Species that feed on foods that display temporal variation in distribution and abundance (e.g. nectar, fruits), need to track these food resources through the landscape. For example, honeyeaters and lorikeets that feed on flowering eucalypts or understorey shrubs, need to move between habitats in response to the

phenologies of these plants. In fragmented landscapes, roadside linkages may assist birds to move through inhospitable farmland habitats, while also providing a food source in the roadside vegetation itself. Certainly, several authors (Newbey and Newbey 1987; Cale 1990; Lynch and Saunders 1991) have reported seasonal changes in the abundance of nectarivorous honeyeaters in roadside vegetation in Western Australia that corresponded with the flowering patterns of trees and shrubs. In western Victoria, Middleton (1980) reported observing flocks of up to 60 White-naped Honeyeaters (*Melithreptus lunatus*) flying along roadside vegetation, apparently using it as a refuge while moving.

(iv) Expansion of geographic range

In rare instances, roadside vegetation may provide a pathway that allows a species to expand its geographic range (Bennett 1991). For example, the introduced Common Mynah *Acridotheres tristis* has expanded in a radial fashion from the urban centres of Melbourne and Sydney. The species is common along the sides of highways which have been pathways for its spread (Blakers *et al.* 1984).

Maximising landscape connectivity with roadside vegetation

Practical conservation measures to enhance corridors of vegetation in rural areas, including roadside vegetation, are growing in number and scope. Assessment and mapping of roadside vegetation is presently underway in many municipalities in Victoria, with the objective of developing integrated management plans for roadsides in the area. These programmes are to be supported and encouraged. However, it is important when developing plans for the management of corridor systems, that careful attention is given to measures that will maximise the value of the corridor to overall landscape connectivity and function. This will require recognition of those factors that are

important both for structural and functional connectivity.

Management of the structural connectivity of a corridor system is the most straight forward objective to understand and achieve. It is relatively simple to assess and map the continuity of roadside vegetation, to identify gaps and to target these for revegetation. The value of other structural features, such as patches of remnant vegetation adjacent to corridors, other linkages (e.g. streams) that intersect with roadside vegetation, or the presence of a network of roadside corridors, can also be readily identified.

While structural connectivity is important, it does not necessarily mean that a corridor will be used by a particular animal species. Understanding the functional aspects of connectivity, those factors that determine whether or not a species will use a corridor, is more difficult. Several factors that appear to be important are as follows (Arnold and Weeldenburg 1990; Bennett 1990a).

- (i) **The type and quality of habitat** is important for many species. Does the corridor vegetation provide the habitat and particular resources required by the species of concern? For example, some species may require thick patches of shrubby ground cover as shelter; others, logs and litter for foraging and shelter; and others, tree hollows for refuge during the day. Because roads often cross topographic gradients, there may be considerable variation in vegetation along the roadside (e.g. different forest types on higher and lower terrain), rather than continuity of a single type.
- (ii) With increasing **width**, corridors encompass a greater area of habitat for animals, and become more resilient to habitat change and disturbance along edges.
- (iii) The presence of **predators** (e.g. Fox, Cat) or **competitors** (e.g. a territorial Noisy Miner colony) in the corridor vegetation may inhibit some species

from using a corridor, or impose an increased risk of mortality.

- (iv) The **relative mobility** of animals will influence the type and length of corridor that they can utilise. Many birds, for example, will be able to cross minor gaps and move substantial distances; whereas for small lizards effective connectivity may require corridors with continuous suitable habitat.

Roadside vegetation generally has high structural connectivity, but may often be lacking in attributes important to functional connectivity. The disturbed nature of many roadside habitats and their relatively narrow width are probably important limiting factors. Clearly, detailed studies that examine the dynamics of wildlife populations on roadsides and in adjacent remnant habitats will greatly assist our understanding of the values and limitations of roadside vegetation, and also of the important elements of landscape connectivity.

In conclusion, the limited evidence available suggests that roadside vegetation does have an important role in maintaining and restoring connectivity to fragmented landscapes. **Most importantly, road networks are already in place with extensive strips and networks of natural vegetation already present in the landscape.** Sympathetic management of existing vegetation is the primary requirement for roadsides to make their full contribution to landscape connectivity. Revegetation in selected areas will further this goal. These works can be achieved at a fraction of the cost that would be required to purchase land and develop a comparable system of corridors. In addition, roadside vegetation has a range of other important values, including contributions to land protection and ecological sustainability of rural environments.

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Roadside Management Within VIC ROADS - An Overview

Graeme Stone*

Introduction

VIC ROADS has a prime responsibility to provide a safe and efficient road system for the movement of people and goods on most State Highways, freeways, tourist roads and forest roads. Municipal Councils are responsible for roadside management on most main and unclassified roads. The total declared road network in Victoria amounts to 160,000 km.

Road reserves were created particularly to provide property access and as transport corridors however, road managers must be aware of other uses and values.

Some perceptive people recognised the environmental value of roadsides many years ago and now the value of remnant roadside vegetation is widely recognized in the community. The scattered trees on our rural land are gradually declining in number and condition and are often not being replaced by regeneration. Even greater emphasis is now placed on roadsides and other remnant vegetation areas.

Responsible roadside management involves setting down policies and principles with follow-up education and awareness programs. The VIC ROADS Roadside Management Guide is one tool for improving attitudes towards managing roadsides for a range of values and uses. (The Guide is available from the VIC ROADS bookshop.)

Values and uses of road reserves

The management of road reserves must consider the uses and the values the community places or expects of roads and associated landscapes. Community aspirations for roadsides are changing and roadside management must respond to those aspirations. Roadside values and uses include the following:

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The views expressed in this article are those of the author and may not necessarily be those of VIC ROADS.

Road access. The primary function of a road reserve is to provide property access and to provide for the movement of people and goods locally and between towns and cities.

Service corridor. Road reserves have traditionally been used for services including electricity, gas, water, telephone, drainage and sewerage. Routes outside the road reserve can be more efficient and less damaging to the natural environment and should always be considered.

Flora and fauna conservation. Because much of the private land adjacent to roads has been cleared for agriculture and urban development, roadsides often support the last remaining communities of native vegetation. In some cases these communities are in relatively good condition and are extremely important, particularly as a resource for revegetation works.

Landscape, recreational and amenity values. The scenic and recreation values of roadsides are appreciated by road users. As windows on the landscape, roadsides make a major contribution to the appreciation of landscape quality.

Archaeological, cultural and historical values. Because roadsides have often suffered less disturbance than other land, they may contain sites of archaeological significance such as scar trees and aboriginal middens.

Road Safety. The provision of a safe roadside environment for the road user is a major objective of all road providers. On rural arterials with high traffic volumes clearance to fixed objects including trees is of concern to safety interests. Clearing of existing vegetation should be selective and consideration given to all roadside and community values.

There are many reasons for conserving native vegetation on roadsides, some of which are:

- preventing land degradation resulting from soil erosion and salinity.
- providing habitat for native fauna including rare and threatened species.
- providing corridors for the movement of wildlife between areas of native vegetation.
- protecting rare and endangered species of plants which have been lost on other land.
- conserving genetic variation of flora species for their potential economic and scientific value and long term survival of the species.
- improving public awareness of nature conservation and providing opportunities for education in flora and ecology.

The values inherent in roadside vegetation and the many uses demanded of that 'thin green line' defined as the road reserve can produce considerable conflict. The situation can be defused by good communication, education and a willingness to appreciate that although road reserves were originally set out with a single objective in mind - transport and access - today the community has multiple objectives.

Management of existing roadside vegetation

It is relatively easy to manage a roadside for the functional roles it may have to accommodate such as transport, electricity, fire prevention, etc. The challenge is to conserve and enhance other values often lost due to single-objective management in the past.

A prime objective of roadside management today is increasingly the conservation and enhancement of flora and fauna values.

Currently, both government strategies and a public ground-swell have supported conservation of roadside vegetation and remnant vegetation generally. In Victoria the State Conservation Strategy has given status and impetus to roadside vegetation assessments and related roadside management plans. The Native Vegetation

Clearance Regulations and the Flora and Fauna Guarantee Act give weight to the conserving of indigenous flora on roadsides.

Roadside assessments

Mechanisms contributing to better management include roadside assessments and management plans. Surveys or assessments of vegetation and the determining of the corresponding conservation status of roadsides are often carried out by community groups. Assistance from the Roadside Conservation Committee, shire officers or the Department of Conservation and Environment helps such groups provide useful information for road managers.

Prior to the preparation of a management plan one must have the best knowledge possible of what flora and fauna values exist on the particular roadside. Professional biological and botanical surveys are desirable where roadworks are imminent or planned in areas of conservation significance. Scientific botanical data is desirable for all roadsides but cannot always be justified or funded and so community assessments become a valuable resource.

On the Western Highway between Beaufort and Horsham VIC ROADS has had a detailed botanical survey carried out with a view to collecting floristic data to assist future management of the natural values of the roadside. The botanical consultants also gave advice on management techniques to try and counter some of the degradation and weed problems that were found. Further botanical surveys are underway on over 700 kms of Highways in the Western Region but at a broader level of detail. The surveys of the Borung, Wimmera, Sunraysia, Henty and Western Highways will show plant communities and their quality.

Broad surveys of the conservation status of highway roadsides have also been carried out in the South Western, Northern and North Eastern Regions of VIC

ROADS. Management plans will be developed from this data and more detailed botanical surveys carried out as resources permit and needs arise.

Roadside management plans

In roadside management generally there are of course many competing interests - fire prevention, vegetation conservation, road safety, construction and maintenance activities of roads and utilities, aesthetics etc. Fortunately compromise is possible on many conflicting issues but poor communication and understanding or appreciation of another's perceptions or needs can lead to unnecessary conflict.

Roadside management plans provide a process or structure whereby the road management authority can:

- (i) assess conservation and other roadside values.
- (ii) consider what are the objectives for management of a particular road from all community perspectives.
- (iii) review what management or maintenance tasks should be programmed to achieve the objectives.
- (iv) communicate and consult with interested and affected parties.
- (v) educate, instruct and train workers and others.

In Victoria preliminary roadside management plans have been prepared by VIC ROADS for the Princes Highway, Sale to Bairnsdale, and others are being prepared for the Great Ocean Road and the Hamilton Highway. Some shires have entered into the roadside management plan process as discussed Committee article.

Education, training and awareness

Education and training of road and utility workers is an important aspect of effective management. Staff cannot be expected to protect values which they do not appreciate nor are committed to. Often damage is done to remnant roadside vegetation through works being carried out with good intent but without proper knowledge.

With this need in mind the Victorian

Roadside Conservation Committee is currently active in the development of accredited courses to meet the needs of municipal and other authorities in roadside worker training.

Good communication can reduce unnecessary conflicts and also bring forth resourceful community members who are often surprisingly knowledgeable of the natural and botanical content of their roadside; knowledge and information that may be costly to obtain professionally.

Initiatives by individuals, municipalities and organisations have often led to commendable roadside conservation projects. The discovery of a special site may now be followed by signing to raise awareness and provide protection to a flora site. The Victorian Roadside Conservation Committee in conjunction with VIC ROADS has developed a system of signing 'special environmental areas'. This project is discussed in the RCC article in this issue.

Community based environmental groups can also assist roadside conservation by conducting workshops and field days and through special hands on efforts to remove threatening environmental weeds as is often done by 'Friends' groups, Landcare and like groups.

Case studies in roadside conservation

There are many individuals, community groups, departmental and municipal officers who care about the conservation of remnant roadside vegetation. Many farmers are active in encouraging others to take a fresh look at what is outside their front gate while protecting their own valued roadside. Although there are understandably many demands still made on those narrow strips of land - road reserves, there are many case studies of special efforts by individuals and groups with a vision.

The following are typical of some of the positive roadside initiatives that are becoming increasingly commonplace.

Great Ocean Road

On the Great Ocean Road which is managed by VIC ROADS South Western



Roadside management conflicts: The regeneration under the power line is delayed and the wide ploughed firebreak has eliminated any native understorey.



Roadside management conflicts: The power line is well placed on cleared farmland but the road to fence ploughed firebreak has eliminated native understorey and prevents any regeneration.

Region the local environment group 'Angair' have assessed the roadside vegetation and provided useful botanical input to the roadside management plan. A sharing of needs at a meeting of service authorities and the fire brigade has resulted in a compromise fire prevention plan for part of the road. It will protect the heathland community encouraging its regeneration for the benefit of tourists and for conservation. The botanical expertise of 'Angair' members will continue to assist VIC ROADS management of the road through 'their patch'.

Hamilton Highway/Shire of Hampden

Roadside conservation committees or management or advisory committees provide a most useful resource and catalyst for action. Concerned individuals are able to express their concerns for roadside conservation and provide a focus for environmental skills and initiatives.

The Remnant Vegetation Committee in the Shire of Hampden is a good example of farmers, school teachers and others pooling their skills and enthusiasm to assist the local Shire fire brigades and VIC ROADS. An amateur botanist, Michael Sturmels, has compiled a detailed plant list and has catalogued many sites some of which have subsequently been signed. Some species recorded and of apparent local significance include *Craspedia* sp., 'Derrinallum', *Diuris* sp. aff. *lanceolata*, *Prasophyllum affine*, *Swainsonia behriana* and an undescribed *Thelymitra* species. Some local farmers are acutely aware of the native flora on their patch of roadside and rigorously protect it to the benefit of the wider community.

Lessening road construction impacts - Western Highway, Victoria

The impact on roadside vegetation of road construction works is often exasperated by long standing practices of 'tidying-up' the site at the finish of the job. During construction also the whole width of the road reserve is often used for side-tracks, stockpiles, machinery parking and manoeuvring etc.



Derrinallum Secondary College students examining remnant vegetation on Chatsworth Road, one of the most significant grassland reserves in the Western District. Photo: V. Lang.

To increase the workers understanding and awareness of the value of roadside vegetation Jim McGuire, an officer with the Department of Conservation at Horsham, took action. With the co-operation of VIC ROADS engineers and the construction contractors an on-site meeting was held with the machinery operators. Jim explained the value in leaving understorey undisturbed where possible and a limit for stripping and machinery movement was agreed upon. Trees were carefully removed by felling back into the construction zone and all machinery parking and turning was also confined to the works area.

The benefit to roadside conservation was apparent and the construction and engineering personnel also gained satisfaction from a job well done.

Conclusion

Balanced management of roadsides is not an easy task given the many competing interests for such a narrow strip. Assessment of roadside botanical values can be aided greatly by the input from knowledgeable and enthusiastic locals. Roadside Management Plans should help as a tool to record important data and to improve consultation, raise awareness of all roadside values and as a consequence, lead to better roadside management.

Victorian Roadsides Conservation Committee

Anne Dennis*

The Roadsides Conservation Committee is an independent body comprising representatives of Commonwealth and State authorities, conservation organisations, professional associations and other bodies with an interest in roadsides.

The committee is concerned about linear reserves. That is, rail and road reservations, whether in use or disuse, stream reserves and other land suitable for linear reservation. Matters relating to individual roadsides are referred to the appropriate member bodies of the committee for attention.

To achieve the objectives the committee works on raising awareness in people involved with the planning and management of linear reserves as well as the community at large. The committee emphasises the importance of:

Roadside vegetation, its associated fauna and other roadside features of historic, cultural or landscape significance;

Considering impacts on the natural environment when using roadsides, of planning, designing or constructing works;

Service installation and revegetation programs.

The committee's main aim is to raise understanding within the community of the importance of remnant vegetation, especially on roadsides and within other linear features. The objectives of the committee are:

The preservation and restoration of indigenous vegetation communities on linear reserves.

The preservation of rare and endangered species of flora and fauna that occur on linear reserves.

The maintenance and enhancement of habitat and corridor requirements for indigenous fauna.

The achievement of a high landscape quality on roadsides.

The prevention of land degradation in linear reserves.

Victoria has 158 000 km of roads and 6500 km of rail reserves. Historically these reserves were established as corridors. They facilitated the movement of people and goods across the country. As the technology of transport developed so did the extent and complexity of our transport network. But generally they were considered to be primarily for the purpose of communication and transport.

Now, due to a growing awareness within the community of the need to manage land in a more environmentally sensitive manner, these reserves are no longer considered to be just for the movement of people and goods.

The importance of road and rail reserves has been recognised in the State Conservation Strategy, but as yet no formal process exists to ensure that the conservation values of reserves are maintained.



Most remaining populations of the rare *Ptilotus macrocephalus* are found on roadsides.
Photo: R. Watson.

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The Roadsides Conservation Committee is actively working towards bringing about improved management of native vegetation in reserves by the following means:

The development of a standardised methodology for assessment of the conservation status of roadside vegetation.

Facilitating community participation in the assessment and management of linear reserves.

Assisting shires and other authorities responsible for the management of linear reserves, to produce management plans.

Encouraging officers of the Country Fire Authority to consider the need for conservation of remnant vegetation.

Investigation of the role roads plays in the movement of wildlife.

Lobbying various sections of government to bring about the introduction of legislative procedures for the management of road and rail reserves.

Promoting the use of a range of roadside signs aimed at the travelling public and workers involved in the management of reserves.

Developing suitable training courses for road managers and construction and maintenance workers.

Organising and participating in seminars in country areas aimed at informing local people of the need to conserve roadside vegetation.

Educating the general community about the values of remnant vegetation through an Environmental Awards program, radio broadcasts and school programs.

Significant Roadside Area



BEFORE DOING ANY WORKS IN THIS AREA

PLEASE RING (055) 623955 AND QUOTE H1

vic roads

To help prevent damage, the Roadsides Conservation Committee of Victoria is encouraging municipalities and VIC ROADS to make use of this roadside sign. The sign has been designed to alert travellers, roadside workers and local people to the value of roadsides.

Linear Reserves Programs of the Department of Conservation and Environment

Keith Watson*

One of the Labor Government's promises prior to the 1985 election was the introduction of a Roadsides Conservation Plan for Victoria, aimed at improving the management and protection of flora and habitat on roadsides and railways. The Department of Conservation and Environment (DCE) was thereby given a clear charter for promoting conservation works on linear reserves. Consequently is embarked on a pilot program to encourage municipalities in its Geelong Region to develop roadside management plans. This program was later adopted by the Roadsides Conservation Committee which has since proved itself to be, not only an appropriate body to do the job, but a leader in promoting and facilitating the assessment of roadside values and the preparation of management plans. The number of municipalities involved in the program is burgeoning. As the roadsides story is the subject of Anne Dennis' article on the Victorian Roadsides Conservation Committee in this issue, I shall confine the rest of my article to the Department's programs on railway reserves.

The railway reserves vegetation management plan

Many road and rail reserves, although not originally set aside for nature conservation, are now highly valuable as habitats for endangered species and as remnant plant communities because surrounding land has been cleared. Railways are particularly valuable, having been fenced off from grazing stock for a long time and subjected to a burning practice that generally favoured native vegetation. This plan aims to identify and protect remnant vegetation and to encourage railways personnel to take advantage of native grasslands in their fire management.

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DCE first negotiated a management agreement with the Railways in 1984 after engaging a consultant botanist to assess the conservation value of vegetation on country lines. This agreement eventually became part of a formal licence agreement signed and sealed by the two respective departmental heads.

The licence enables DCE to carry out protective works on sites that are listed on a schedule as botanically significant. These works are spelt out in a general Management Plan, along with actions that are to be avoided by Railways works operators.

The Management Plan designates four categories of vegetation. The management of both Category 1 (Rare Plant Reserve) and Category 2 (Significant Native Plant Community) sites places responsibilities on DCE and, in the case of Category 2 sites, on the Railways also. For Category 3 (Predominantly Exotic Vegetation) and Category 4 (Predominantly Exotic Vegetation) sites, guidelines are prescribed for Railways management.

Although all the Cat. 1 and Cat. 2 sites have been marked by coloured stakes and are known to the Public Transport Corporation's (PTC) regional "Road



Mallee vegetation along railway line between Mildura and Ouyen.

Foremen", there is still a lot of fencing and proper sign-posting to be done by DCE. It is most gratifying to know that a number of fences are going up around rare plant sites every year. Equally pleasing is the preparation of detailed management plans and action statements that is now underway in various DCE regions.

A most heartening phenomenon of recent times is the interest being taken by local community groups in managing remnant flora sites on railway reserves. These volunteers are keen to compile species inventories, collect seeds, control weeds and prepare management plans, and DCE naturally welcomes their help. One problem is the safety of volunteers entering active railway reserves and persuading PIC to indemnify, and DCE to insure, the volunteers. Is is not always a difficult problem. There has to be strict control to allay the special problems and anxieties experienced by The Met. Nevertheless, I know of several voluntary bodies that have adopted sites on The Met and are working successfully under Met guidelines.

The majority of the sites on the schedule are located on operational railway lines but, in some cases, disused lines are involved - sites on the latter will eventually become Public land under DCE management; their inclusion on the schedule is an interim arrangement.

The disused railways planning process

When a railway line is constructed, it becomes a unique resource to the State. In time it becomes virtually a non-renewable resource. If its transport function ceases it should not be disposed of without careful consideration of its continuing usefulness as a linear reserve. The line may offer a unique opportunity to protect remnants of the original flora and fauna or to enhance land protection programs (for example action against tree decline). It may have value, now or in the future, for uses such as communications and recreation - perhaps even the return of a transport function.

In the mid-eighties, forty-five railway lines were closed down in Victoria. In the past it was V/Line's practice to sell sections of a closed line to the adjoining landholders. This time V/Line called for expressions of interest from DCE (along with other statutory bodies) and DCE ended up running a planning process to determine the future of disused railways.

The essential features of the planning process are as follows:

1. Initially, a resource inventory of the line is carried out by DCE.
2. Community consultation involving calling for expressions of interest.
3. An Advisory Committee (AC) making decisions by consensus.
4. Guidelines given to the AC by DCE regarding government policies to be followed.
5. A planning officer (resourced, so far, by DCE).
6. The process itself is a product of consultation, having been forged within a working group of the Municipal Association of Victoria with representation from DCE, Ministry of Transport and Green Australia Inc. and with referral to groups such as the Conservation Council of Victoria, the Land Protection Council and the Victoria Farmers Federation.

To date, ten out of the forty-five lines have been subjected to the planning process. One (Hamilton to Coleraine) has achieved the final product - a management plan that details usage, tenancy and management prescriptions and that has been approved by the Ministers of Transport and Conservation and Environment. The other nine lines will soon have approved management plans. In all cases the advisory committees have recommended that the lines be retained essentially as corridors of public land - in concurrence with the first committee's pace-setting statement:

'The Committee is of the view that, as a general policy, the Government should retain ownership of all disused railway

reserves which will thereby remain available to be re-utilised for any future public purpose that may arise. Examples of future uses could include new major roads, new special purpose heavy duty railways, easements for gas or water pipelines, communications conduits or high voltage electricity transmission lines'.

The beauty of this particular planning process is that it achieves at least three very important tasks in the one go: public consultation, agreement about future use (or you may like to call it interim use) and delegation of management. Commonly, advisory committees are recommending management of significant habitats by DCE, public use reserves by Committees of Management, and the majority of the lines running through farmland by adjoining landholders under a licence. In the latter case, DCE and Greening Australia meet with the adjoining landholder on site in order to determine what tree-planting or vegetation protection conditions are to be written into the lease. Lessees who plan to use all the land for conservation purposes are charged only a nominal rental.

It is not easy to give high priority to disused railways during a time of recession. At least we have been able to keep the program going - with Priority Victoria funding, for example, to enable a planner to work for six months in each of two DCE Regions. DCE is also approaching the councils of municipalities with closed lines to propose that they help resource the planning process. Currently two Shires are taking a lead in the process, with DCE carrying out the initial resource inventory and generally overseeing the exercise.

During a visit to the United States last year I visited the Rails to Trails Conservancy in Washington D.C. This organization successfully promotes and assists the retention of old railway reserves for new uses. As of May 1991, 415 former railways were converted to trails throughout the U.S. Americans are realizing the

immense opportunity to convert former railways into corridors for nature conservation, walking, running, skiing, horse-riding, wheelchair use, snowmobiling and other purposes.

Americans have invented 'railbanking' - a method of which lines proposed for abandonment can be preserved through interim conversion to recreational trail use. In 1983, the US Congress, concerned by the rapid contraction of America's rail network, amended legislation to create the railbanking program. It seems that we in Victoria are achieving the same end, not by legislation, but by sensible decisions made in local communities.

Although the US experience can teach us a lot about community benefits from recreational corridors, Victorian closed railways seem more suited to tree-growing and habitat corridors at this point in time. Nevertheless, the Minister, in a recent statement ('Protecting Victoria's Environment and Natural Resources', 11 June 1992) has raised the profile of linear reserves, such as road and rail reserves, as recreational as well as habitat corridors by announcing that the Government will 'institute a significant program of on-ground works to enhance existing linear reserves'. Three disused rail lines - Nyora to Wonthaggi, Minhamite to Port Fairy and Dennington, and Ballarat to Skipton - have been designated for works as soon as possible.



Remnant grassland flora on a railway reserve.
Photo: R. Watson.

Conservation of Rare and Threatened Species in Linear Reserves

Anne Dennis*

While pondering a suitable topic about roadside conservation of interest to readers of this fine publication, two questions emerged and are considered here. Of what interest is the work of the Victorian Roadsides Conservation Committee (VRCC) to a field naturalist, and how important are road and rail reserves really in the conservation of our precious flora and fauna?

Involvement of Field Naturalists in Roadside Conservation

As a community asset on public land the maintenance of linear reserves for conservation requires proper planning. Planning involves firstly an assessment of the resource. Several years ago the VRCC undertook a pilot project in the Geelong region of the Department of Conservation and Environment (DCE) to develop a suitable technique to assess the quality and extent of native vegetation remaining on roadsides. The technique assesses the vegetation together with other attributes such as fauna habitat which allows the conservation value of road reserves to be determined.

Assessments have been completed by volunteers in roughly 15 municipalities while a further 30 Shires are partially completed or considering assessment this Spring. The assessment procedure developed by the VRCC is an assessment of the 'pristineness' of the indigenous vegetation on a roadside. For example, an area with an undisturbed ground, middle and upper storey, without weeds would naturally be of high conservation value. Although there are very few such pristine sites on road reserves, sites which are relatively weed free and retain a high diversity of native flora would usually rate

high. Native grassland areas and other rare vegetation communities also rate high provided they are not excessively degraded. Where one of the vegetation layers is missing (a common scene is one where the larger trees remain, but the shrub and ground layer has been cleared and replaced by exotic grasses) an area may rate a medium conservation value. In the overall rating, the assessment also considers landscape, the presence of fauna species, habitat potential and potential for wildlife corridors. Any threats are also recorded. This type of assessment can be done relatively quickly by two or three people from a car, provided they have fairly good plant identification skills and are able to distinguish weeds from native plants. There are however a number of limitations to this technique: **1. The degree of resolution.** For example, the minimum section length is generally 100 m. If there is a change in the status of the vegetation within 100 m then the whole 100 m section would be rated according to the highest value of any part of the section. **2. Adequate survey of fauna species.** Wide variations in size and numbers would normally be expected, seasonal/migratory variations can occur. The absence of a species in any such survey does not necessarily mean it is absent, it may have been overlooked. **3. Consistency of ratings.** Depending on the nature of the surrounding land use, in some totally cleared areas any remnant occurring on roadsides may be considered highly significant, whereas in well forested areas, a few scattered trees with a degraded understorey would probably rate low. **4. Identification of rare or significant species.** Sometimes assessors do not know the conservation status of an individual species and so when a rare species occurs in a highly degraded area of otherwise low conservation value, it can be easily overlooked.

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Members of the Maryborough, Wangaratta, Geelong and Castlemaine Field Naturalist clubs have carried out assessment of the conservation values of linear reserves in their municipalities. Field naturalists frequently have a good appreciation of indigenous vegetation and the rarity or otherwise of flora within their own locality and so can help to achieve a more accurate assessment. Following completion of the initial assessments, checking the conservation status of recorded species against other information sources can also be useful. In the Shire of Maldon, assessments by the Maryborough Field Naturalists have located and mapped all roadside occurrences of the depleted *Allocasuarina luehmannii* (Buloke) and the vulnerable *Amyema linophyllum* (Buloke mistletoe). This information together with the rest of the assessment data has been provided to the relevant municipal authorities to consider when carrying any road works.

It would of course be preferable to be able to carry out professional detailed botanical surveys of all roadsides. However by seeking the assistance of community volunteers in carrying out assessment, the community becomes more involved in developing suitable management regimes for their roadsides, without excessive cost to the community.

From the assessment, conservation values are mapped onto a Shire road map and management plans are developed by the municipality in consultation with interested groups. Usually, local advisory committees are set up to address all the issues raised in producing a workable management plan and one which satisfies all parties' needs. A community conservation group representative would normally be on the local committee. Objectives to enhance and protect remnants on road reserves can be considered together with other objectives such as to provide safer roads. Management plans are currently being developed in the municipalities of

Gisborne, Yackandandah, Lexington, Benalla, Doncaster/Templestowe, Pakenham, Metcalfe, Phillip Island, Wangaratta, while others including Woorayl, South Gippsland, Sherbrooke, Stawell, Wannon and the La Trobe Region are developing or have developed policies or strategies.

The management plans are not so much about how to manage remnant areas, but rather policies and guidelines on how to plan and carry out normal activities on roadsides without unnecessarily damaging the vegetation. In this way responsible authorities will be more aware of the impacts of their work on vegetation and further losses will be minimised. Vegetation may still be threatened in the long term however through lack of active conservation management.

Importance of road and rail reserves in flora and fauna conservation

Much has already been written about whether small remnants like linear reserves are capable of serving as effective conservation reserves or as habitat corridors and so will not be discussed here. At present, although there are many sources of information in the form of surveys and data bases on locations of flora and fauna species, there is no overall Statewide compilation of information which tells us just how important road and rail reserves are in the conservation of endangered, vulnerable, rare and depleted flora. (The meanings of these terms used here are as defined by Gullan *et al.* 1990) While it may be well understood by many that these areas are important, there is nothing like hard fact to persuade others.

Building up a Statewide picture will be a fairly long process. Provided here in brief are the beginnings of that picture.

Starting with a search of flora and fauna listed or nominated for listing under the *Flora and Fauna Guarantee Act 1988*, it became quickly apparent that road and rail reserves play a very significant role in conservation of species as these areas are often the last refuge of the species before it is pushed to extinction. For example:

Plants known only from populations on road and rail reserves

Senecio behrianus Xx (Thought to be extinct until discovered in 1991 on a road reserve, a roadside drain and an irrigation bank.)

Rutidosis leptorrhynchoides Ee (200 plants disappeared from population of 217 during railworks in 1984. Now presumed extinct from 5 rail reserves where it was previously known to occur.)

Comesperma polygaloides v (Most populations occur on road or rail reserves.)

Senecio macrocarpus Ve

Agrostis adamsonii Xx (Known extant range is on a roadside found in 1987)

Prasophyllum chasmogamum (e, Flora and Fauna Branch, DCE)(Has disappeared from many rail reserves over the past 40 years, less than 100 plants remain.)

Brunoniella pumilio e

Euphorbia planiticola e (The only one well known population occurs on a roadside.)

Diuris cuneata v (Only one population is known to survive.)

Swainsonia brachycarpa v (Limited to two locations on or near a road reserve.)

Plants that occur Primarily on private land and road or rail reserves

Amphibromus pithogastrus Ke

Eucalyptus cadens Ee

Geijera parviflora e

Pterostylis cucullata Vv

Eremophila sturtii e

Acacia havilandii e

Swainsonia galegifolia v



The rare *Rutidosis leptorrhynchoides*.

Photo: M. Taube.

Found on road or rail reserves but with other populations elsewhere

Plants

Eucalyptus froggattii Rv

Adriana quadripartita e (Occurs mostly on roadsides.)

Thelymitra epipactoides Ee

Psoralea parva Ee

Swainsonia plagiotropis Ee

Goodenia macbarronii v (Recorded from 2 roadsides and 2 areas of remnant bushland)

Acacia maidenii e

Acacia glandulicarpa Vv

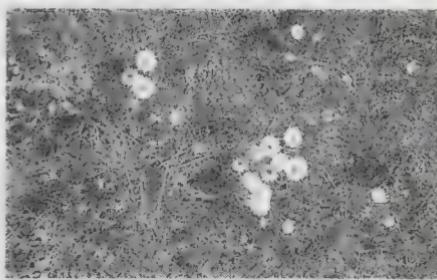
Astelia australiana v

Myoporum floribundum Re (largest known stand on a road reserve)

Communities

Western plains grassland community

Northern plains grassland community



Western plains grassland community.

Photo: R. Watson.

Fauna

Petaurus norfolkensis (Squirrel Glider) (r D.Baker-Gabb 1990)(Threatened by habitat fragmentation.)

Polytelis swainsonii (Superb Parrot) (r D. Baker-Gabb 1990)

Pomatostomus temporalis (Grey Crowned Babbler) (v D. Baker-Gabb 1990)

There are still other listed taxa whose locations on road or rail reserves I have yet to verify.

An exploration of the Victorian Rare or Threatened Database held by DCE which revealed the following species when searched under the land use attribute of road or rail reserve.

Glycine latrobeana Rv
Eucalyptus aggregata e
Discaria pubescens Rv
Lepidium hyssopifolium Ee (Also listed under the FFG Act.)
Leptorhynchos elongatus r
Olearia pannosa v
Prasophyllum diversiflorum Ee

It is possible for amateur botanists to forward information on special information forms for inclusion in this data base. Before being entered, all information is verified.

DCE's Flora Information System data base, held at Kew was also investigated. It is a geographic information system in which floristic data from a range of site-based, area-based and grid-based sources all over Victoria are stored. It was not possible however to search this data base using "roadside or road reserve" as a location or land use attribute as all location information is stored in latitudes and longitudes. A search of the raw survey data would be needed and is a task too large to be considered at present.

All the volunteer assessment data has been searched, but not yet the data gathered by professional consultants in some municipalities. Other sources of information likely to reveal information include various 'Sites of Significance Surveys' which usually cover road and rail reserve areas and various VicRoads surveys as mentioned in the VicRoads article in this issue. I would be pleased to learn of any other readily accessible sources of information to help build the picture.

Under the FFG Act, listed taxa are still not adequately protected. Action Statements for the conservation of these taxa must be prepared. These are negotiated tools for management of sites, but are not legally binding. At best, if activities threaten a listed species, an Interim Conservation Order can be put in place. An IOC halts works for a period while suitable management agreements are entered into. The flora and fauna on linear reserves remain exposed to destruction by

authorities without fear of litigation.

Conclusion

As few of the taxa listed above appear to be adequately protected in other conservation reserves, road and rail reserves have the potential to and must serve as small refugia provided they are managed for conservation purposes. Unless actively managed linear reserves are exposed to continuing threats. Common threats include road widening, construction and rail track maintenance work, spraying for weed control and fire prevention, lack of appropriate fire regimes, weed invasion and competition, disease, slashing and mowing, clearing for utilities, bulldozer and machinery damage, grazing, soil compaction, alteration to drainage, plant collectors, smothering with road making materials and drain spoil, locations of stockpiles, genetic isolation. Introduction of *Phytophthora* infected gravel for road works is listed under the *Flora and Fauna Guarantee Act 1988* as a potentially threatening process.

Despite the efforts of many botanists and environment groups to identify and protect significant sites, many losses are still occurring. The last of known site of *Olearia ciliata* in the Mornington Peninsula was recently destroyed unwittingly by road maintenance workers. Usually, losses occur through a lack of awareness by planners, construction and maintenance crews of CFA brigade members. A lack of understanding of remnant vegetation management or lack of ability to identify plants of significance while carrying out works has been the main cause of continued losses. To help overcome this problem the VRCC has developed a program to mark sites of special flora or fauna significance on road reserves. While in some instances it is desirable to limit the extent of knowledge of the locations of some species, in many cases the losses which occur through ignorance could be minimised by suitable marking. There are two signs available to mark sites, one which

highlights the conservation significance on an area to the general public and a small discreet marker which will help to protect plants from disturbance by road construction and maintenance crews or from fire prevention and weed control works. Sites which have been marked already include: a site containing a regionally significant Swamp Scrub community on a VicRoads freeway on the Mornington Peninsula. No slashing occurs between the markers which allows regeneration to occur; sites in the Shires of Bannockburn and Corio protecting populations of the rare *Prostanthera decussata*, the vulnerable *Pultenaea graveolens* and *Olearia pannosa*, and rare or regionally significant plants *Grevillea chrysophaea* and *Prostanthera nivea*, remnant grassland areas in the Shire of Hampden and Grey-Crowned Babbler habitat in Northern Victoria. The VRCC is maintaining a register of these sites which can be nominated by anyone. The installation of signs requires lengthy negotiations with the relevant authorities and landholders. Management procedures are also worked out prior to marking, and information sessions need to be held with workers to explain the management objectives. To complement this program, the VRCC is also currently developing a training program for road engineers, planners and construction and maintenance workers to increase their awareness and to explore more sensitive approaches to works. One of the biggest obstacles remaining in the protection of our precious flora and fauna on linear reserves is the will to change.

Note: Abbreviations used to define the conservation status of plant species in this article are taken from Gullen et al. 1991

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Woodlands along rural roads contribute to the character and appeal of the rural environment as well as providing habitat for wildlife.

Notes on the Wildlife of a Disused Railway Reserve in Western Victoria

Andrew F. Bennett*

Abstract

Observations of wildlife were made along a section of the Koroit-Hamilton railway reserve in south-western Victoria. This railway line is one of 46 lines throughout the State that are no longer required for operational purposes. Thirty-nine species of birds, six species of mammals, four species of reptiles and four species of frogs were recorded from limited observations in remnants of natural vegetation occurring along the reserve. These preliminary results are presented to illustrate the range of wildlife species that can utilise this linear reserve, and to point to the potential value of wildlife of such reserves in cleared rural environments.

Introduction

In the largely cleared landscapes of rural Victoria, remnant vegetation along streams, roadsides and railway reserves, can be an important supplement to the scattered remnants of native vegetation retained on private and public land. Linear strips of vegetation on road reserves have been documented as contributing to the conservation both of flora and fauna (Middleton 1980; Krohn 1981; Yugovic *et al.* 1985; Stuwe 1986; Bennett 1988). Rail reserves have been identified as important sites for the survival and conservation of some rare plant species and communities, particularly native grasslands (Stuwe 1986), but there is no published information on the fauna of railway reserves in Victoria.

This paper presents observations on the fauna of the Koroit-Hamilton railway reserve in south-western Victoria. This railway line is one of 46 lines throughout Victoria that the State Transport Authority has determined are no longer required for operational purposes. The Department of Conservation and Environment is presently

co-ordinating a programme that will determine the future use and management of these lines.

Study Area

Observations of wildlife were made along the Koroit to Hamilton railway reserve, mostly between Woolsthorpe and Minhamite railway stations. The pre-settlement vegetation of this area was mainly grassy woodlands dominated by Manna Gum (*Eucalyptus viminalis*), Swamp Gum (*E. ovata*), Blackwood (*Acacia melanoxylon*), Black Wattle (*A. mearnsii*), and a tree form of Silver Banksia (*Banksia marginata*). The understorey was dominated by native grasses, particularly Kangaroo Grass (*Themeda triandra*), but also species of the genera *Danthonia*, *Stipa* and *Poa*. In moist areas, shrubs such as Prickly Teatree (*Leptospermum continentale*), Prickly Moses (*Acacia verticillata*) and Tree Everlasting (*Helichrysum dendroideum*), and the Saw Sedge (*Lepidosperma laterale*) were present under a canopy dominated by *E. ovata*.

Natural vegetation in this area has been almost entirely cleared for farmland (Bennett 1982; Woodgate and Black 1988), and the typical landscape is composed of grassy paddocks with occasional plantations of pines, cypress or the introduced Sugar Gum (*Eucalyptus cladocalyx*). Scattered indigenous eucalypts are present around Woolsthorpe and Hawkesdale townships and a single disturbed remnant of forest (60 ha), half of which was purchased by the Victorian Government in 1989 for nature conservation, is present near Woolsthorpe. Other than these areas, remnant native grassland and patchy lines of shrubs and trees (mostly *Acacia*) along some roadsides and the railway reserve are the only

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remaining examples of the pre-settlement vegetation.

Vegetation along the railway reserve (40 m width) reflects its past management. Areas that have been heavily and frequently grazed are almost devoid of native species; while in areas where grazing is light or absent, native grasses (especially *T. australis*) are prominent and trees and shrubs such as *E. viminalis*, *E. ovata*, *A. melanoxylon*, *A. mearnsii* and *B. marginata*, may be present. Stuwe (1986) rated the 10 km section from Hawksdale railway station to Minhamite station as being of high conservation value, both for the presence of rare species (e.g. the plains form of *Banksia marginata*) and for the native grassland community rich in native species.

Methods

Casual observations and brief searches for wildlife along the railway reserve were made on irregular occasions from 1985 to 1990. Birds that were seen or heard within the reserve were noted and mammals were recorded by sightings and by characteristic signs. Reptiles and amphibians were located by turning logs, discarded sleepers and rocks. In December 1988 and December 1989, birds were recorded during censuses of 20 minutes duration at eight sites. All birds seen or heard within the reserve were recorded while walking slowly along a transect of approximately 300 m length.

Results

Birds

A total of 39 species of birds was recorded from the railway reserve (Table 1). The birds noted from the reserve can be assigned to four main groups; introduced species, birds of farmland and open habitats, woodland and forest birds, and birds of wetlands and streams.

Five species, Blackbird, European Goldfinch, House Sparrow, Common Starling and Skylark are introduced, and all are widespread and common through

farmland. They are not dependent upon natural forest or woodland vegetation. European Goldfinches were particularly common in the rail reserve vegetation. Skylarks were common in adjacent grassy paddocks and occasionally were seen in grassy vegetation in the reserve.

At least eight species can be regarded as farmland or open country birds that occur in this area in the absence of native forest or woodland vegetation. Most of these are widespread and common residents; Australian Magpie, Australian Magpie-lark, Little Raven, Willie Wagtail, Yellow-rumped Thornbill and Welcome Swallow. The Brown Falcon is also widespread in farmland, and Stubble Quail fluctuate in abundance depending upon seasonal conditions. Several additional species, Red Wattlebird and New Holland Honeyeater, occur around gardens in towns and on farms.

The largest group, of some 20 species, are characteristically associated with woodland or forest vegetation. Some species, such as Red-rumped Parrot, Long-billed Corella, Black-faced Cuckoo-Shrike, Restless Flycatcher, Eastern Rosella and Noisy Miner, are typically associated with open woodlands or woodland edges. Others, such as Golden Whistler, Rufous Whistler, Brown Thornbill, Yellow Thornbill, Striated Pardalote, Laughing Kookaburra, Grey Fantail, and Yellow-faced Honeyeater are more dependent upon remnant natural vegetation for both foraging and nesting. Many of these species are occasionally sighted in isolated trees in farmland, in plantations or farm gardens, but they are rarely resident and only occur regularly where there is remnant natural vegetation.

A final group are those species usually associated with wetlands; White-faced Heron, Pacific Black Duck, Masked Lapwing, Latham's Snipe and Clamorous Reed Warbler. Latham's Snipe were flushed from dense grassy cover in a moist area of the rail reserve in both 1988 and 1989; and Masked Lapwings were noted at several

moist areas. The other species were noted where a small creek crossed the railway reserve.

Mammals

Three introduced mammals, Fox (*Vulpes vulpes*), Brown Hare (*Lepus capensis*) and European Rabbit (*Oryctolagus cuniculus*) and three native species, Short-beaked Echidna (*Tachyglossus aculeatus*), Fat-tailed Dunnart (*Sminthopsis crassicaudata*) and Common Brushtail Possum (*Trichosurus vulpecula*), were recorded from the railway reserve. The three introduced species were each seen at several locations along the reserve and all are widespread throughout local farmland. The Fat-tailed Dunnart is uncommon in farmland, where it is occasionally found under logs, fenceposts, or rocks. A single individual was found on the railway reserve, under a discarded sleeper. Brushtail Possums are widespread, but the Short-beaked Echidna is rare in the cleared farm landscape. These species were all recorded by casual observations. Systematic techniques (e.g. spotlighting, trapping) to survey native mammals were not used.

Reptiles and Amphibians

Four species of frogs, Southern Brown Tree Frog (*Litoria ewingii*), Common Froglet (*Ranidella signifera*), Striped Marsh Frog (*Limnodynastes peronii*) and Spotted Marsh Frog (*Limnodynastes tasmaniensis*); and four species of reptiles, White's Skink (*Egernia whitii*), Water Skink (*Sphenomorphus tympanum*) (cool temperate form), Grass Skink (*Leiolopisma entrecasteauxii*) (Form B) and Copperhead (*Austrelaps superbus*), were recorded from the railway reserve.

Frogs were recorded from moist areas along the rail reserve, either at a creek crossing, adjacent to a swamp, or where pools and ditches form on the reserve during winter. Most records were of individuals found under logs or rocks. The Common Froglet and Spotted Marsh Frog were noted calling during the day at a pool

on the reserve. These frogs are widespread in the remaining swamps and wetlands in the district.

The Grass Skink was the most commonly encountered reptile, being noted from eight sites. White's Skink was also common, and was found at four sites under sleepers or rocks. The Water Skink was found under logs in two places, and a single Copperhead was observed basking on rocks adjacent to a marshy area.

Discussion

Limited observations at irregular times have recorded the occurrence of 39 species of birds, six species of mammals, four species of reptiles and four species of frogs on the railway reserve. This is an incomplete survey; further sampling, particularly on a seasonal basis, is likely to reveal the occurrence of additional species in each of these faunal groups. However, the purpose of this note is to illustrate the range of species that can utilise the patchy natural habitats along this linear reserve; and to point to the potential values of such linear reserves for maintaining wildlife in environments that have been extensively cleared for agriculture.

The primary value of the railway reserve to wildlife, as indicated by the present observations, is as a linear habitat through farmland. Patches of woodland, grassland and wetland habitats along the reserve offer habitats to species that rely upon native vegetation, as well as to species that are able to utilise farm environments. Together with other scarce remnant vegetation, the railway reserve makes an important contribution to maintaining wildlife in this rural environment.

The potential value of this railway reserve to wildlife conservation could be greatly enhanced by protection and rehabilitation of remnant vegetation, and re-establishment of vegetation in those sections that have been degraded. This would increase the quality and the total area of natural habitat available to wildlife,

and also restore a continuous corridor of natural vegetation through the farmland. Effective management of narrow linear reserves poses a challenge; but the opportunity to restore a continuous corridor of natural vegetation, extending some 80 km from Koroit to Hamilton through the cleared farm landscapes of western Victoria, is unlikely to ever again be realized.

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Table 1. Birds recorded on a disused railway reserve in western Victoria. Values represent numbers of individuals recorded at eight sites during 20 minute censuses in (a) December 1988 and (b) December 1989.

Species	Sites										Other	
	1 1989	2 '88	2 '89	3 '88	3 '89	4 '88	4 '89	5 '88	5 '89	6 '88	6 '89	
White-faced Heron												*
Pacific Black Duck												*
Brown Falcon		1		1						1		
Stubble Quail												
Masked Lapwing												
Latham's Snipe												
Long-billed Corella												
Crimson Rosella												
Eastern Rosella												
Red-rumped Parrot												
Horsfield's Bronze-Cuckoo												
Shining Bronze-Cuckoo												
Laughing Kookaburra												
Skylark												
Welcome Swallow												
Black-faced Cuckoo-shrike												
White-winged Triller												
Blackbird		1										
Golden Whistler												
Rufous Whistler												
Restless Flycatcher												
Grey Fantail												
Willie Wagtail	2	3			4	1	6	2		3	2	4
Clamorous Reed-Warbler												
Brown Thornbill	6	7		3	1	2	8	10	3	4	5	6
Yellow-rumped Thornbill	2	16	1		1	7	3	6	2	2		
Yellow Thornbill					2	2	1					
Red Wattlebird												
Noisy Miner												
Yellow-faced Honeyeater												
New Holland Honeyeater												
Striated Pardalote	1					1						
European Goldfinch		11	6		4	12	17	23	6	9	14	26
House Sparrow		5	2		4				5	2		
Common Starling		26	4		2	1		1		2		1
Australian Magpie-lark	1	3					2	4			2	
Australian Magpie	4	1				3	1	2	3	2	2	
Little Raven		2				1			10		2	
Raven sp.												

Protecting Remnant Vegetation from Sea-winds

T. Offor*

Many people are aware that sea-salt plays an important role in coastal plant communities, selecting for salt tolerant species and moulding the shape of more salt sensitive ones. However, few realise that the influence of the sea goes far beyond what is typically thought of as the coastal zone. Strong winds, such a common feature of the southern Australian coast, carry sea-salt large distances inland. Sea-salt is detectable in rainfall many hundreds of kilometres inland (Hutton and Leslie 1958), sea-salt crystals being important nuclei for the formation of raindrops. In the USA, sea-salt carried on hurricane force winds defoliated forests up to 75 km inland (Moss 1940). There are also Australian examples. In the Margaret River region of south-western Western Australia, wind-borne salt is suspected to be the cause of severe damage to grapevines, depressing grape yields by 80% or more in some vineyards (Hingston and Galbraith 1990). And closer to home, a dairy farmer on a property north of Wonthaggi in western Gippsland reports that his beans are pruned off at fence level by sea-salt every time a decent southwesterly change hits — and he lives 15 km from the coast! (Gus Hales, pers. comms.).

The salt carried on sea-winds is produced at the surface of the ocean — sea-water droplets ejected by bursting bubbles. These microscopic droplets of sea-water are swept up by strong winds and carried inland. The amount of sea-salt in the air decreases exponentially with distance from the coast, since sea-salt particles fall out under gravity, are impacted on vegetation and are carried further up into the atmosphere. However, in some localities regular exposure to sea-salt causes dieback of forests and isolated trees, what I shall call airborne salt induced dieback. In southeastern Australia this is

most common inland of windy, southwest oriented coastlines, such as the west coast of Victoria or the coastline between Cape Liptrap and Cape Woolamai in western Gippsland (Fig. 1). However some airborne salt damage is common close to most ocean coasts, large bays and even salt lakes.

My research in the Wonthaggi region has shown that the most susceptible localities are on south or west facing hillsides, within 30 km of the coast, particularly in relatively treeless rural areas. Elevated sites in hilly regions are particularly vulnerable because wind velocities increase towards the top of hills, resulting in the vegetation intercepting greater quantities of sea-salt. In these exposed locations the vegetation will often die back from the seaward edge, taking on some of the structural characteristics of salt-pruned coastal vegetation.

Under natural conditions, prior to forest clearing, salt-laden winds were carried over the top of the forest since vegetation in near-coastal regions naturally develops a streamlined profile. However, clearing for agriculture has resulted in a pastoral landscape dotted with isolated trees and remnant forest patches. Today this remnant vegetation experiences a very different environment to the one which existed prior



Fig. 1. The stippled zones indicate regions where airborne salt induced dieback is common.

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to clearing. These remnants are often exposed to the full force of salt-laden winds, where previously they would have been part of a forest community protected from wind.

Identifying dieback caused by airborne sea-salt

Dieback from sea-salt generally appears as dead branches on one side of a tree or, in more severe situations, as dead trees on the seaward side of a forest remnant (Fig. 2). Epicormic shoots (produced from dormant buds beneath bark) are common and they may be killed off on the seaward side so that they too appear asymmetrical.

The canopy of remnant stands may show distinctive changes. Tall canopies which are grazed or have little understorey so that wind can readily penetrate beneath the canopy, will become layered and will progressively die back (Fig. 3). Remnants which have a substantial understorey will also die back to some extent on the seaward side, but the understorey forces the wind over the top of the remnant and a stable, aerodynamic profile is formed (Fig. 3).

Salt damage to foliage is quite characteristic. Young foliage is most susceptible to salt entry and is therefore the best place to look. The tip and often also margins of a salt-damaged leaf will be necrotic, generally within a day or two of a strong southwest wind. New epicormic

shoots are particularly vulnerable due to their exposed location on the trunk, and they may be reduced to almost leafless twigs within a few days of a strong sea wind.

Some of the most salt sensitive species, and therefore good indicators of airborne sea-salt, are introduced plants such as hawthorn, (*Crataegus monogyna*), wild plum (*Prunus domestica*) and apples (*Malus spp.*) — all common weeds of rural roadsides in southern Victoria. Eucalypts are also fairly sensitive, however, the young foliage is readily damaged by strong winds alone, which also cause tip death, and this can be confused with salt damage. The best indicators of salt damage are plants with small leaves which are not readily wind damaged. Death of leaf or shoot tips following strong sea-winds is a good indicator of sea-salt damage.

Plant shape is also a good indicator of the influence of sea winds. Strongly asymmetrical shrubs and trees which are oriented in the direction of the prevailing sea wind are strong evidence of sea salt. Roadside vegetation is useful for this purpose since it is quickly and easily surveyed.

Managing remnants exposed to sea winds

Edges of forests are typically lighter, warmer, windier and have lower humidity than the interior of the forest (Williams-Linera 1990). They may also receive nutrient and water inputs from the surrounding landscape. Their biota is typically different, with a greater diversity of organisms sharing the edge environment. Edges are also often weedier than interiors since they are readily accessible to propagules dispersing from surrounding communities. The ratio of edge to interior in a remnant is related to the shape of the remnant, with linear remnants or corridors typically being all edge (Laurance and Yensen 1991).

The amount of wind penetration into the edge will determine the extent of damage from airborne salt. Linear



Fig. 2. Dieback of the seaward edge of an exposed remnant eucalypt forest in west Gippsland, 15 km from the coast.

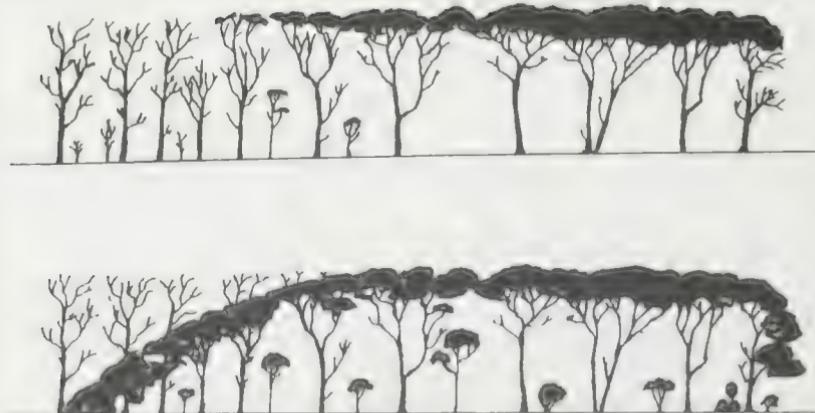


Fig. 3. Characteristic forest structures resulting from exposure to airborne sea salt. (top) Tall forests with little understorey or frequently grazed forest. (bottom) Forests with substantial understorey.

remnants suffering from sea-wind damage will show the same symptoms as any other remnant, but the extent of the damage may be far greater due to their narrowness. The orientation of the remnant is particularly important. Remnants which expose a substantial amount of edge squarely to the prevailing sea wind are most vulnerable.

A management strategy should be targeted towards encouraging regeneration of understorey and canopy species on the seaward side. A dense growth of vegetation will force salt-laden wind over the top of the canopy, protecting the remnant from progressive decline. Disturbances, such as grazing, should be minimised on the seaward edge to encourage regeneration. Likewise problems may arise in roadside remnants with power-lines on the seaward edge, since regular canopy pruning allows more wind into the canopy and prevents the closure process which would otherwise naturally occur.

Managing a remnant to prevent the penetration of sea-winds is very compatible with other conservation objectives. A dense understorey provides habitat for mammals and birds, at the same time it may act as a barrier for airborne weed propagules, reducing the weediness of the remnant.

One of the aims of corridor manage-

ment should be to encourage the development of an interior environment which is suitable for the passage and possibly residence of interior species. Interior species, in contrast to edge species, require the more stable environment of the interior of a patch for habitat. Managing a linear remnant for reduced wind penetration is very compatible with encouraging the development of an interior environment.

New plantings in near-coastal regions

Anyone contemplating revegetation within 30 km of a windy ocean coast should consider the influence that sea-salt will have on the plants. Figure 4 shows a suggested plants design for salt-exposed localities. Dense-growing, moderately salt-tolerant shrubs should be planted on the seaward edge. These should be followed by taller, moderately salt tolerant species and finally by tall species such as eucalypts. The salt-tolerant species on the seaward edge provide shelter for the taller-growing, more salt sensitive species, allowing a reasonably tall belt of vegetation and therefore better wind protection to leeward. This approach can be used for narrow windbreaks, broadscale plantings or to seal up the edge of a remnant exposed to sea-winds.

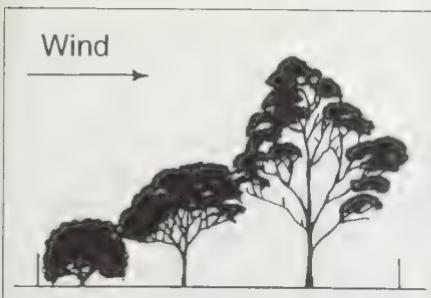


Fig. 4. Suggested planting design for exposed localities.

Deciding if a remnant is vulnerable to sea-wind damage

A predominance of dying branches or trees on the seaward edge of a remnant is a strong clue that a directional factor such as airborne salt is involved.

The following criteria increase the likelihood that airborne salt is responsible for the dieback. For areas other than southern Australia the compass bearings should be changed to that of the prevailing sea wind and the stated distances may not be relevant. The points are listed in decreasing order of importance.

- The edge of the remnant is oriented parallel to a windy, southwest facing coast.

- There is no sheltering vegetation to windward.
- Isolated trees and shrubs on roadsides are strongly asymmetrical and orientated towards the southwest.
- The remnant is on a seaward facing hill within 25 km of a windy ocean coast or on flat land within 15 km of a windy ocean coast.
- The canopy trees are tall with a large amount of free space beneath their crowns.
- The remnant is grazed or mown.

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Cats and Wildlife in Victoria: A New Approach

Uncontrolled cat populations are continuing to devastate wildlife in Victoria. Many species face local extinction or major reductions in numbers due to cat predation or from diseases spread by cats. DCE's 'Protect your Cat, Protect your Wildlife' education campaign is based on a new strategic approach to the problem.

Complementing a Responsible Pet Ownership campaign being implemented by the Department of Food and Agriculture, the campaign addresses the basic welfare of both cats and wildlife. Community awareness of the impact of pet cats on wildlife is an essential precursor to community support for compulsory identification, registration and desexing. A Statewide requirement for these factors will effectively separate the pet and feral (or stray) population and reduce recruitment into wild populations.

What Happens Next — Road Side Conservation

M.R. Gilbert*

Abstract

The report demonstrates a practical application of roadside vegetation conservation in a developing outer metropolitan municipality. Having assigned conservation values to all road reserves, roadside conservation strategies were adopted and implemented in areas of fire prevention works, roadside vegetation regeneration, State Electricity Commission assets and road construction.

Introduction

Roadside Conservation - one wonders if after all the demands have been placed on a road reserve for the provision of services, whether it is possible to save any of the roadside vegetation. By the time the State Road Construction Authority's Design Guidelines are complied with in respect to pavement width, shoulders and roadside drains; the Farmers cut down the trees along their fence line to prevent limbs falling on their fences; the State Electricity Commission cut the trees to code to protect the power lines; Telecom removed vegetation to trench in communication cables; and the Fire Authority requests a bare earth policy from fence line to fence line for fire prevention, a roadside can be left barren.

The destruction of roadside vegetation in the provision of services can be devastating, however, all is not lost, as it is possible to co-ordinate and accommodate the wide range of demands on a road reserve and still preserve the natural beauty and often unique species of vegetation along the roadside.

Gisborne Shire

Gisborne Shire is 50 kilometres north west of Melbourne encompassing part of the Macedon Ranges and includes the township of Mt Macedon, Macedon, New Gisborne and Gisborne. The area has a constant growth rate of six percent, with seventy-five percent of the working population commuting outside the Shire.

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The Macedon Ranges form an important part of the natural beauty of the area with most road reserves being heavily timbered.

In 1983 the Ash Wednesday bush fires devastated two-thirds of the area of the Shire and destroyed over 500 houses, commercial, and public buildings. In the aftermath there was concern within the community over such matters of effective roadside fire hazard control, the re-establishment of roadside vegetation and the need to ensure the natural beauty of the area was restored.

Roadside conservation assessments

In October 1984, a roadside evaluation survey was carried out to determine a conservation rating for the roadside vegetation for most roads within the Shire. The evaluation technique and guidelines were prepared by personnel from the Arthur Rylah Institute (Department of Conservation and Environment) and the Ministry of Planning, who used local members of the Macedon Ranges Conservation Society to carry out the physical assessment of each road.

From the survey each road assessed was assigned a conservation value of either low, medium or high and these were colour coded onto a large scale map of the Shire for easy reference.

What next — implementation

The establishment of roadside conservation values is the first step in preparing an overall roadside management plan.

In the Gisborne Shire the results of the

assessments have been used in implementing roadside conservation strategies in four main areas:

- (a) Fire Prevention Works
- (b) Roadside Vegetation Regeneration Control
- (c) State Electricity Commission assets
- (d) Road Construction

Fire prevention

Council, through its Fire Prevention Committee, comprising members of all local Fire Brigades, Country Fire Authority, Department of Conservation and Environment, Councillors and Council Officers had already drawn up a 'Fire Prevention Plan' for the Shire which categorised roads into Strategic and Tactical fire breaks with recommendations for degrees of roadside clearing to achieve the desired 'Fire Safe' environment.

The Fire Prevention Plan was overlayed with the Conservation Assessment Plan and where conflict occurred between listed fire prevention works and conservation values, generally where extensive roadside clearing was recommended on a roadside with a high conservation value, onsite meetings were held to determine appropriate treatment to satisfy both needs.

Through an appreciation of the outcomes desired by all parties, satisfactory solutions were obtained. The following illustrates some of the treatments agreed to and which have now been implemented in the Gisborne Shire.

Block treatment - Mt Macedon Road

Mt Macedon Road is a Main Road connecting the Calder Highway to the townships of Macedon and Mt Macedon. The road has been assigned a High Conservation Value rating and is also classified as a Strategic Fire Break. Much of the roadside vegetation was burnt in the 1983 fires requiring a large number of mature trees to be removed. The fire also initiated vigorous regeneration regrowth. During the conservation assessment survey localized areas of rare native orchids were

also identified. The potential conflict of extensive roadside clearing to achieve the required Strategic Fire Break, and the need to retain the natural road side beauty, especially as the road is the gateway to Mt Macedon, was resolved by preserving 'blocks' of undisturbed vegetation and native orchids.

The 'block' areas were physically roped off by Shire Staff in consultation with members of the local Fire Brigade and Macedon Ranges Conservation Society. The remaining areas were then slashed in accordance with the Fire Prevention Plan.

The result has been the retention of an attractive roadside landscape, the preservation of the orchids and satisfactory fire prevention works to prevent a fire from spreading along the roadway (Fig. 1).

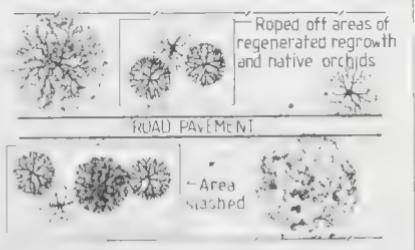


Fig. 1. 'Block' Treatment

Strip clearing - along fence lines

A second method of achieving a suitable fire break and still retain the important visual roadside was to combine the fire break with the need for clearing along an S.E.C. power line located along one of the fencelines of the road reserve. The area from the fenceline to the code distance from the powerlines towards the road pavement was cleared off all trees and slashed. This left substantial mature trees still remaining between the cleared area and the road itself (Fig. 2).

Litter fuel reduction

Many roads within the Shire have large well established trees on the roadsides with dense undergrowth. The conservation assessment of these roads is weighted high

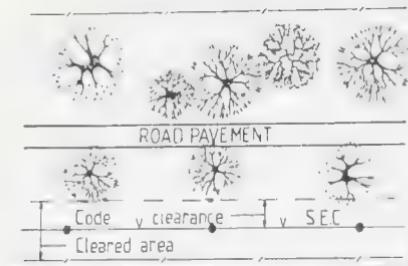


Fig. 2. 'Strip' Clearing

due to the large trees. To maintain the visual attractiveness of the large trees and to maintain adequate fire prevention standards, the undergrowth is removed by slashing using a telescopic mower and in some areas by hand slashing. In some instances residents whose properties abut these roads do the work.

Roadside vegetation regeneration control

The need to control the vigorous regrowth on roadsides after the 1983 bush fires was necessary to ensure the re-establishment of an attractive roadside landscape and meet the requirements of other bodies, such as the Fire Prevention Committee.

This has been achieved by adopting the 'block' and 'strip' methods as described earlier.

State Electricity Commission assets

A Tree Clearing Co-Ordination Committee was established for the Shire of Gisborne in 1976. The Committee with representatives from the State Electricity Commission, Shire, Department of Conservation and Environment, Macedon Ranges Conservation Society and other interested parties, was established to control and co-ordinate the tree trimming practices of the State Electricity Commission. The Committee members would inspect all powerlines prior to the State Electricity Commission tree cutting crews commencing works. The members would walk along the route of the S.E.C. conductors and physically mark all trees

to indicate whether they should be totally removed, lightly trimmed or limbs removed. This achieved a desired standard which meant the trees were not mutilated, but were trimmed aesthetically and the State Electricity Commission achieved their desired code clearance.

With this background of co-operation between the State Electricity Commission and Council, other works have been initiated to preserve the landscape value of road sides. These have included:

- Undergrounding State Electricity Commission assets
- Relocation of power lines
- Combined State Electricity Commission/Fire Prevention clearing
- Aerial Bundled Cable

Undergrounding State Electricity Commission assets

Preservation of existing trees

After the 1983 bush fires, there were few roadsides remaining on Mt Macedon which retained their former canopy of trees. Only two such areas were untouched by the fire.

Both these sections of road contained State Electricity Commission power lines which, if cut to code, would require the removal of the only remaining green trees on Mt Macedon and destroy the canopy effect over the roadway. The two roads were part of the Mt Macedon Road and Brougham Road.

Mt Macedon Road - The funding of undergrounding 1.3 kilometres of high voltage and low voltage powerlines was jointly provided by the Council and the State Electricity Commission through monies made available from special funds for the relocation and undergrounding of powerlines. The Gisborne Council was the first to take up these funds. The Council carried out the trenching works and paid a \$30,000 cash contribution with the State Electricity Commission paying the balance.

The end result is the retention of a magnificent avenue of trees, which if not protected by undergrounding would have

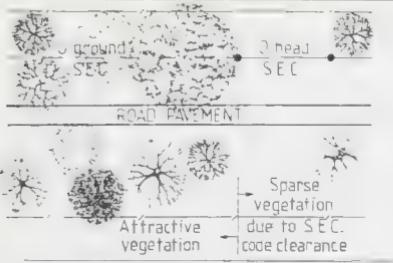


Fig. 3.

been removed and a barren landscape left as illustrated in Fig. 3.

Brougham Road — The funding for the undergrounding of this short section of powerline was provided by the local residents and from the State Electricity Commission's Undergrounding Special Funds on a 2 for 1 basis. The locals contributed \$4,500 and the State Electricity Commission \$9,000. The raising of the funds and applications of the State Electricity Commission Undergrounding Committee was organised by the Shire. The desired result was obtained with a complete canopy of trees remaining over the road. Both sides of the road would have been cleared if cut to the State Electricity Commission code.

Undergrounding to aid replanting

Devonshire Lane on Mt Macedon was renowned for its magnificent avenue of Mountain Ash prior to the 1983 fires. The trees were burnt in the fire and required removal. State Electricity Commission overhead lines ran the full length of the south side of the road. The local residents and Council were keen to re-establish the lane, however, with the State Electricity Commission's code of tree cutting it was not possible to re-establish Mountain Ash. The residents under the co-ordination of the Council raised \$16,000 local contribution and attracted a 2 to 1 grant from the State Electricity Commission's Undergrounding Funds.

The powerlines have now been installed underground and the naturally regenerated Mountain Ash are being allowed to grow

thus re-establishing the magnificence of the lane way. Had the over head lines been retained the regenerating Mountain Ash would have had to be removed.

Relocation of Power Lines

In many instances the State Electricity Commission, through the recommendations of the Tree Clearing Co-ordination Committee, earlier described, have relocated powerlines to preserve either a particular species of tree or stand of trees. This has been achieved through three different practices (Fig. 4):

- (a) Zig zagging powerlines from one side of the road reserve to the other and back again;
- (b) Using one side offset crossheads on the power poles instead of the standard "T" construction allowing poles to be located closer to trees than normal; and,
- (c) Staggering the standard offset of the powerlines but still remaining on the same side of the road reserve.

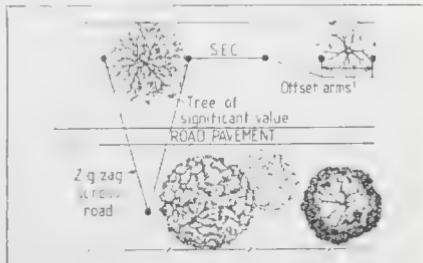


Fig. 4.

Combined State Electricity Commission/Fire Prevention assets

Coffey Road, Bullengarook, to the west of the Shire passes through a heavily timbered area and is designated as a Strategic Fire Break Road and also attracted a high conservation value. State Electricity Commission power lines travel the length of the road on the west side. To achieve the desired roadside clearances for both the State Electricity Commission and Fire Prevention Committee, it was agreed to completely clear fell all timber between

the road seal and the fence line along the western side of the road, and leave untouched the vegetation on the eastern side. The State Electricity Commission felled and cleaned up the trees, 'munched' the stumps to ground level and the Shire has undertaken to annually slash the area. Although the clearing was in excess of the State Electricity Commission's code requirements, the treatment has achieved an effective fire break and with the timber preserved on the eastern side of the road has retained a pleasant roadscape (Fig. 5).

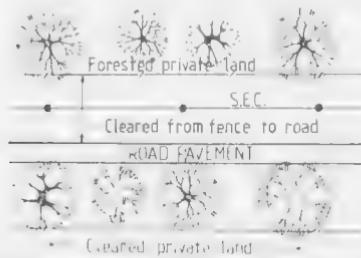


Fig. 5.

Aerial Bundled Cable - (ABC Cable)

Aerial Bundled Cable, comprising of heavily insulated conductors twisted together to form a single cable, has recently been introduced into Victoria by the State Electricity Commission. The ABC Cable reduces the amount of tree clearing to meet code distances because the ABC Cable is a single strand instead of the normal three strands spread on a cross arm, and because the ABC Cable is heavily insulated allowing branch overhang and reduced clearance distances from the conductor itself.

Low Voltage ABC Cable is now in use throughout the Shire and its introduction has saved the need for heavy pruning of trees where it had been installed. An example is Alton Road, Mt Macedon, where the road reserve has a canopy of Oak Trees meeting across the pavement. Use of standard conductors would have destroyed the canopy, however, the use of ABC required only a "hole" around the

cable to be cut preserving the effect of the trees.

High Voltage ABC Cable up to 22 KV is only in the experimental stage and it is expected its use will be introduced in the near future. The use of ABC Cable for both low and high voltage distribution is an important advancement in the protection of the roadscapes (Fig. 6).

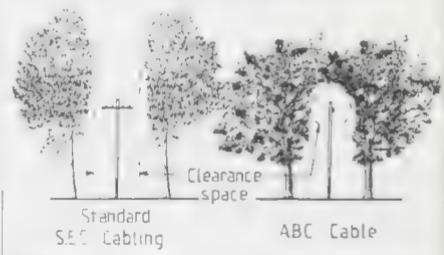


Fig. 6.

Road construction

The Gisborne Shire has for a number of years recognised the importance of preserving the roadside landscape. With increasing urbanisation, and the area being a very popular 'day tripper' tourist attraction for people from metropolitan Melbourne, growth in vehicular traffic volumes has been rapid. This has applied pressure on Council to upgrade many roads, some from gravel to seal surface or widening existing narrow-scaled roads.

To achieve the protection of the roadside vegetation, cater for the increased traffic volumes and to provide better road conditions expected by todays motorists, the Council adopted modified design standards and construction techniques which were sympathetic to the environs and provided improved road surfaces.

The modified design and construction techniques used included the following:

- Reduced road design speed values;
- Reduced vertical alignment to minimise cuts and fills which cause massive earth disturbance and tree removal;
- Reduced horizontal alignment. Generally any new road works follow

the existing road alignment to minimise disturbance to roadside vegetation;

- (d) Road pavements constructed without shoulders to minimise overall width of roadworks;
- (e) Roadside drains placed directly against the sealed road pavement;
- (f) Reduced clearance between the edge of pavement and existing trees. In many instances the road horizontal alignment "meanders" between trees which are left close to the pavement.

In the Gisborne Shire a popular tourist route which passes through the Barrung Area in the foothills of Mt Macedon consisted of a network of gravel roads which carried high traffic volumes including tourist and commuter traffic. These roads were sealed using the modified design and construction techniques with the upgraded road generally following the existing alignments of the gravel roads, winding amongst the trees and following the natural contours of the land.

Some problems have been experienced with the road side drain scouring the side of the pavement, and in some areas beaching has been carried out to prevent erosion. However, after one year, the growth of grasses in the drains has stabilized the erosion and are now trouble free.

The overall result has been very effective with a sealed road network free of maintenance and the retention of the natural roadside landscape.

Of interest is the acceptance by the motorists of the lower standards of road geometry with traffic travelling at the appropriate speed and even though buses use the road network no accidents have been reported to date, yet as a gravel road network road accidents were frequent.

Conclusion

The Roadside Evaluation Assessment is the first step in formulating policies regarding the management of the roadsides. It is a necessary tool in

discussions with other bodies who are involved in the use of the roadsides, as it gives an important basis on which to encourage other parties to co-operate in the preservation of the roadside vegetation.

It is possible to achieve co-operation between various authorities and local bodies to achieve the desired result of preservation of the roadside landscape. It is time consuming with many meetings, but the end result is rewarding and it has worked in the Gisborne Shire.

Where to now?

Roadside Management Plan

With the practices developed in the Gisborne Shire to protect the roadside vegetation, the Victorian Roadside Conservation Committee chose to prepare a comprehensive 'Gisborne Roadside Management Plan' based on those experiences.

Through an Advisory Committee comprising representatives of all road reserve users, the plan, now in draft form, addresses all issues involved in roadside management in the municipality and sets us specific policies and guidelines for each activity, culminating in detailed management prescriptions for each individual road. Issues addressed include vegetation management, fauna, pest plants, utility services (S.E.C., Water Boards, Gas), road construction and maintenance, site rehabilitation, fire management, driving and many more.

The Gisborne Council will be adopting the Management Plan as policy in September 1992, and the V.R.C.C. intend to circulate copies of the Plan to all Victorian Municipalities to use as a reference in the preparation of their own management plans.

Roadside operators course - protecting native vegetation

A two day workshop for field personnel working on road reserves has been put together by the V.R.C.C.

The course objectives are to give an understanding to the field people of the need to protect the native vegetation, how to recognise indigenous vegetation, construction and maintenance techniques to avoid unnecessary damage to the vegetation and methods of enhancing the native vegetation by rehabilitation and planting techniques.

The course was recently piloted with the Outdoor Staff of the Gisborne Shire with great success, and will now be fine tuned and packaged for marketing to all authorities who have field personnel working on a road reserve.

S.E.C. audit and management plans

Through the local Tree Clearing Co-ordination Committee mentioned earlier in the article, a management plan detailing long term strategies to resolve the conflict of power lines and trees is being prepared for the Macedon and Mt Macedon area.

Each power line, span by span is inspected by the Committee and the vegetation under and near the power lines assessed for the long term management to reduce the amount and frequency of tree clearing required by the S.E.C. each year. These solutions may include replacement of power line with ABC cable, relocating the power line to a less sensitive area of the

road reserve, removing and under-grounding power lines, removing inappropriate vegetation from underneath the lines and replanting with more appropriate indigenous species and encouraging private landholders to plant more appropriate species of plants near power lines. In some areas, it is recognised a yearly trim will always be necessary as no other solution is available.

Once the audit has been completed, a management plan will be prepared detailing the longer term strategies and this will be binding between the S.E.C. and Council. Action plans will then be developed to achieve the longer term aims. Already the S.E.C. have replaced much of the bare wire low voltage power lines with A.B.C. cable in some of the areas.

It is the aim of the Tree Clearing Co-ordination Committee to ultimately use the Management Plan for application to the S.E.C. to have the Macedon/Mt Macedon area cleared as one of "Particular Significance" under the S.E.C. Act; thus achieving a permanent recognition of the importance of the natural vegetation of the area and having in place an enhanced chance of preserving it where the conflict with S.E.C. power lines exists.

This paper was presented at the Local Government Engineering Conference, Hobart, August 1991. The final section 'Where to now' has been written since.

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Preservation of Camberwell's Natural Heritage

Colin Singleton*

'The remnants of pre-European Camberwell are interesting for their rarity.' This statement from Volume 2 of the Camberwell Urban Conservation Study (p. 91) succinctly sums up the current status of Camberwell's natural heritage; that there is very little evidence remaining of this city prior to urban development.

The City of Camberwell is a definitive example of Australian suburban life, perhaps even being labelled a 'classic suburb'. Camberwell, like many other Melbourne suburbs, was first subdivided for farmland, with early purchases being made in the 1840's. Lot sizes from 10 to 200 acres were sold, with the smaller holdings being ideal for dairies and orchards, the larger for grazing land. It wasn't until the 1880's did much of Camberwell's rural land attract suburban subdividers.

The desired image of Camberwell during the 1880's was of an English countryside, of hedges and flowering bushes. Landholders, wanting to cash in on the 1880's building boom, did their utmost to eliminate stands of native vegetation, when drawing up subdivision plans and clearing land in readiness for the numerous dwellings which would rapidly establish the character of the city as we know it today.

Camberwell basically grew from the centre outwards, with villages springing up around transport nodes, firstly the railway routes in the 1880's and the tram routes in the 1920's. The majority of Camberwell developed during the period between the wars, from 1918 to 1940's. A number of popular house styles appeared, from the Californian Bungalow, English revival (perhaps with Tudor details), Mediterranean influence (commonly called "Spanish Mission") through to the Modernist movement with its flat roofs and curved walls.

It was during this period that vast areas of farm land were cleared for housing. New roads were built and old roads were widened, gullies were filled and creeks were barrelled, to utilise every available area of land for residential development. All these actions resulted in the loss of our natural environment.

During the 1880's parliamentarians and local Councillors and residents alike saw a unique opportunity to enhance Melbourne's fledgling rail system, by constructing an outer circle route from Oakleigh to North Melbourne. This route would pass through the cities of Malvern, Camberwell and Kew on its way to the City. Work began on the outer circle line in 1885 and it was opened in 1891. However the project was an abject failure and sections of the line were soon to be closed. The section through Camberwell has remained in use, being electrified in 1924.

The outer circle route through Camberwell passed through what was known as the 'Ashburton Forest', which, it was said, attracted day trippers from the city and suburbs. Local residents regularly fought to save parts of the forest as Camberwell's development rapidly changed the face of the local environment.

A plant list for the Ashburton Forest was compiled in the 1930's and information relating to this area was included in the publication 'The Flora of Melbourne'.

In the 1950's very little remained of the forest apart from some 'gnarled eucalypts in the yard of St Michael's School' *Camberwell Urban Conservation Study, Vol. 2, p. 91*, in Warner Avenue and a stand of River Red Gums along the outer circle rail line. Today these River Red Gums along the rail line perhaps provide the last remaining environs of pre-European Camberwell.

* Urban Designer, City of Camberwell, Camberwell, 3124.

Council policy

Camberwell Council has a strong commitment to preserve the city's heritage. This not only includes its cultural and built heritage, but also its natural heritage. However, Camberwell does not have a great deal of its natural heritage left, due to the continuous suburbanisation of the city.

Certain areas of Camberwell have been identified as containing remnant indigenous vegetation which botanists' reports have shown to support a variety of indigenous plant species, some of which are rare in the eastern suburbs of Melbourne. These areas which contain remnant indigenous vegetation, include the Alamein Rail line, Beckett Park, Balwyn, Gardiners Creek valley, Glen Iris, Koonung Reserve (formerly Koonung Creek valley) in North Balwyn and Belmont Park, Balwyn.

Council is currently developing and implementing management plans for the preservation or re-establishment of the natural vegetation in these important areas.

The site

Along the southern section of the outer circle line over 100 different native species can be found. The most significant (or naturally intact) area along the line lies between Burwood Station and the overpass near Dion Street, Burwood. The land on which the remnant vegetation is contained is a narrow reserve between the top of the railway cutting and the edge of Welfare Pde, a local road (Figs. 1 and 2).

Volume 93 of *The Victorian Naturalist* (pp 180-181) included an article by T. B. Muir relating to remnant indigenous vegetation, in the area between Burwood and Alamein Stations. Also surveys undertaken by the Department of Conservation and Environment (formerly Department of Conservation, Forests and Lands), along Melbourne's rail reserves, have identified this area to contain significant remnant indigenous vegetation.

This particular reserve is characterised by an upper storey of River Red Gums

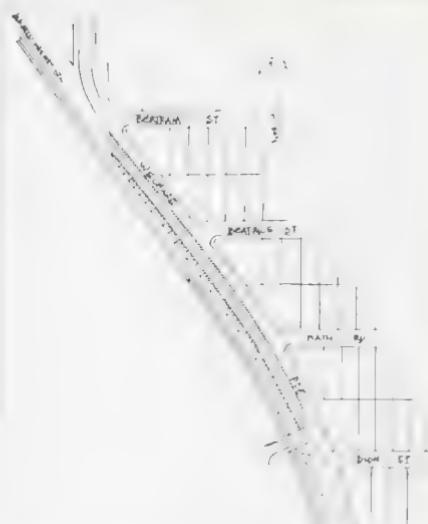


Fig. 1. City of Camberwell, Welfare Parade Indigenous Vegetation Reserve, Locality Plan.

(*Eucalyptus camaldulensis*), which at one time covered much of this part of the city (Refer Fig. 3). These trees provide a canopy to a whole host of native wild flowers and grasses. Plant species such as the small Grass Tree (*Xanthorrhoea minor*), Chocolate Lilies (*Dichopogon strictus*), Kangaroo Grass (*Themeda triandra*), Wallaby Grass (*Danthonia spp*), Pale Flax-lily (*Dianella longifolia*) and Bulbine Lily (*Bulbine bulbosa*) have been identified in the reserve.



Fig. 3. Indigenous vegetation reserve, Welfare Parade, Camberwell.

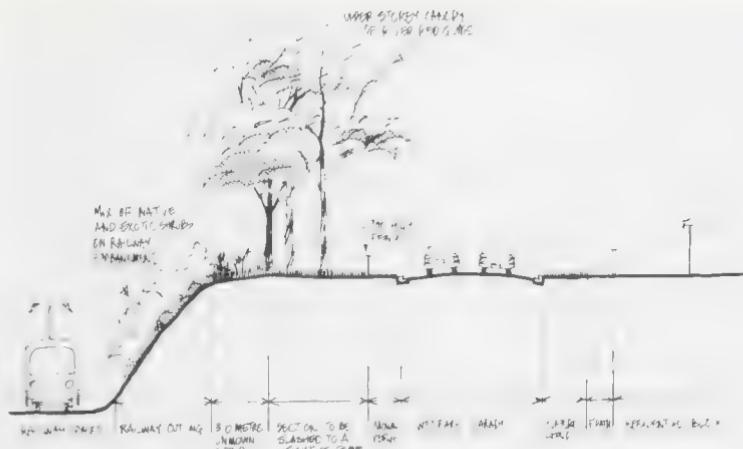


Fig. 2. City of Camberwell, Welfare Parade Indigenous Vegetation Reserve, a typical cross section.

In the past these indigenous ground plants have not proliferated due to a number of factors, including Council's continual mowing regime for the area, (which was primarily based on the local residents' desires to reflect a neat English urban appearance for the road verges), plants being trodden on by passers by or dug up by animals or plants being smothered by dumping of garden rubbish by local residents.

As the ground plants dared to outgrow their exotic neighbours they would be cut down, to maintain the "neat" nature strip appearance, which in turn provided the exotic weeds, such as Wild Oats (*Avena fatua*), Kikuyu and Couch grass a chance to further invade this area and to smother the smaller plants.

Council, as the management body for this area, were asked to review their mowing program for this area to assist on the re-establishment of the indigenous ground plants, just begging to show their heads.

This request came from Green Link Camberwell, a local community organisation formed to encourage appreciation of native vegetation.

Council in conjunction with Green Link Camberwell and the Public Transport

Corporation (seeing that some of the plant material was growing on their land, although maintained by Council), formulated an appropriate management plan for the area which it was hoped would suppress the exotic weeds leaving the area dominated by native species.

Objectives of the management plan

The objectives of the management plan are to:

- establish a sustainable maintenance program for the site;
- actively involve the community in the project;
- encourage a wider community appreciation of the heritage value of remnant vegetation areas.

The management plan

The management plan for this site involved a number of actions related not only to the re-establishment of existing native species but also to provide an attractive urban road reserve.

A visual survey of the site revealed that certain areas within the site supported different levels, or densities, of indigenous plant species. Generally speaking there were three different categories, viz; areas which contained a high level of native plant

species, (both in number and variety), areas which supported some native species with some exotic weed invasion, and areas which basically supported only introduced weed species.

The particular management action to be implemented was dependant on the particular area's level of native vegetation.

In general the management plan pursued the following actions. It should be noted that this management plan is continually evolving, as our working knowledge of the site increases and as a result of trialling different techniques.

1. The project site was fenced to protect the plants from being trodden on, or being disturbed by animals as well as to minimise the instance of local residents dumping garden refuse on the site (which may contain seeds from exotic species, and/or smother the smaller native species).

This 900 mm high post and wire fence was set back some 1.8 metres from the kerb of Welfare Parade to enable pedestrians to walk along the grassed edge of the road. This grassed edge is being mown regularly to maintain driver visibility and to alleviate residents' concerns regarding any fire risks of unmown grass.

2. The areas which support the highest level of native species, mainly along the top of the embankment, are being left unmown to preserve the diversity of indigenous species which occupy these areas. The majority of species worthy of preservation can be found in a 3.0 metre wide strip parallel to the top of the embankment.

Hand weeding of exotic species is the main management technique in these areas. Also spot slashing (whipper snipper), as well as some spot application of herbicide, to remove unwanted plants, is sometimes carried out.

3. The areas which support a medium level of native species (between the fence and the unmown areas) are being slashed to

a height of 150 mm at strategic times to control the invasion of weed species while causing minimal disturbance and damage to the indigenous herbs and grasses found in these areas. Certain individual plants and areas are staked to protect them from unnecessary slashing.

4. The most degraded areas, ie; those areas which support few native species, are being sprayed with weedicide and mulched (by Camberwell Council). These areas are then replanted with indigenous wild flowers and grasses grown from seed collected in the local area, and propagated at Camberwell Council's nursery (by Green Link Camberwell) (Refer Fig. 4). One aim of this project has been to try to propagate some of the more rare native species, along with the common species, in an endeavour to re-establish a variety of native species, in this area, particularly those species which have become scarce in the eastern suburbs.

Ongoing project tasks

This project has been proceeding since 1989. During this time over 2000 native plants have been planted by the community under the direction of members of Green Link Camberwell. Members of Green Link have also identified and staked a number of individual plants to protect them from being slashed as well as for future reference for possible seed collection.

The various maintenance actions are being monitored by both Council officers and Green Link members. If the native ground plants start to proliferate, as anticipated, some of the maintenance actions (such as slashing) can be reduced or ceased.

At present Council is investigating methods of combatting an infestation of lerp-forming insects in the River Red Gums. Several bird boxes will be placed in the trees in an endeavour to attract more native birds into the area. Also a variety of native shrubs, such as Cherry Ballart



Fig. 4. Planting of native wildflowers in mulched areas, Welfare Parade, Camberwell.

(*Exocarpus cupressiformis*) and Sweet Bursaria (*Bursaria spinosa*) will be planted, to attract not only bird species, but also other natural insect predators. A plant list of appropriate species is currently being compiled from similar and, where possible, geographically close, River Red Gum woodland environments. It is hoped that an increase in the native bird population will assist in decreasing the insect population.

Green Link Camberwell

Green Link Camberwell meet every second Sunday of the month, at 3.00 pm, on site, near the overpass, corner of Dion Street and Welfare Parade, Burwood. A big spring planting is planned for this year and members of the public are welcome to participate in the planting of numerous grasses and wild flowers in this area.

Funding

This indigenous vegetation project has been jointly funded by Camberwell Council and a grant from Go Green, a State Government funded program set up to sponsor the re-establishment of the state's native plant species.

The funds, which total some \$18,000, have covered the costs of fencing, seed collection and propagation, mulch, stakes, weedicides, and explanatory signs to be erected on the site.

Summary

This project has now been underway for over two years. The various maintenance actions undertaken have proven very successful and the native plant population is thriving. Camberwell Council and Green Link Camberwell will continue to work together to hopefully achieve the ultimate aim of creating a totally sustainable environment which will require minimal maintenance.

It is anticipated that a similar program will be initiated along other sections of the rail reserve, especially the area south of High Street, Ashburton. These sections may be far more degraded, but none the less support hidden stands of indigenous plants just waiting for a chance to flourish.

It is interesting to note that the vegetation's proximity to the rail line, which was built to supposedly boost suburban growth, has paradoxically safeguarded this remnant of pre-urbanisation.

Nature Conservation 2: the Role of Corridors

Reviewed by Tim Offor

D. Saunders and R.J. Hobbs (eds) (1991).

Published by Surrey Beatty and Sons,

45 Rickard Road, Chipping Norton NSW 2170.

*Available direct from the publishers or from leading
Natural History Bookshops. RRP AUD\$80.00 plus postage.*

'Nature Conservation 2: the Role of Corridors' is the second book in Surrey Beatty's Nature Conservation series. The series commenced with 'Nature Conservation: the Role of Remnants of Native Vegetation', the proceedings of a conference on the management and conservation of remnant vegetation and its associated fauna, held in Busselton (WA) in 1985. The first book has firmly established Australia at the forefront of international research into the ecology of remnants.

'Nature Conservation 2: the Role of the Corridors' is the proceedings of a conference on the biology and management of corridors, held in Busselton in 1989. It comprises 38 chapters arranged into four major themes: Inventory and assessment of corridors; Values of corridors; Movement of biota; and Management, establishment, maintenance and rehabilitation. Each theme is introduced by a review paper. The final section in the book contains summaries of 17 of the conference workshops.

This is a book written for scientists and land managers. All papers have been refereed and rigorously edited. A smattering of limericks (the products of a limerick competition at the conference) add a pleasant touch of humor. A

comprehensive index of more than 14 pages greatly adds to the usefulness of the book.

Many authors conclude their chapter with a discussion on the implementation of their research for management and conservation. This marks a positive step since the majority of landscapes discussed are severely degraded with little remnant vegetation and urgent action needs to be taken to conserve the biota.

The editors have synthesized some of this information into a 20 page booklet titled 'Guidelines for bush corridors'. This booklet gives an overview of the major findings of the conference. There would seem to be ample information now available for a book targeted at farmers and public land managers, explaining in greater detail how to create and manage corridors, and incorporate them into agricultural land management.

'Nature conservation 2' makes a significant contribution to the international literature on the role of corridors. I look forward to the publication in 1992 of the third book in the Nature Conservation series: 'Reintegrating Fragmented Landscapes: Towards Sustainable Production and Nature Conservation'.

This review is reprinted, with permission, from Growback'91 (Growback Publications).

Books Available from FNCV

The Club has, over the years, published a number of books on natural history topics. It is currently distributing three of these as follows, which titles can be purchased from the Book Sales Officer:

What Fossil Plant is That? (J.G. Douglas).....\$8.00

A guide to the ancient flora of Victoria, with notes on localities and fossil collection

Wildflowers of the Stirling Ranges. (Fuhrer & Marchant)\$7.95

144 magnificent photographs of the spectacular flora of this region

Down Under at the Prom (M. O'Toole & M. Turner)\$16.00

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We also hold a stock of the following:

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BOOK SALE

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At the General Meeting on **Sunday, September 6th 1992**.

WHERE

Herbarium, in the Hall

WHAT

Books and periodicals withdrawn from the FNCV Library

WHY

Stock has to be cleared to make room for the more important material

HOW

Bargain prices! Not to be missed! You may be lucky!

Sheila Houghton
(Librarian)

The Field Naturalists Club of Victoria

In which is incorporated the Microscopical Society of Victoria

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Membership of the F.N.C.V. is open to any person interested in natural history. *The Victorian Naturalist* is distributed free to all members, the club's reference and lending library is available and other activities are indicated in reports set out in the several preceding pages of this magazine.

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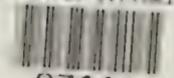
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October



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FIELD NATURALISTS CLUB OF VICTORIA



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FNCV Calendar of Activities

November

Sun 1 General FNCV Excursion. Whipstick area of Bendigo. Orchids and other flora, birds and geology. Contact Dorothy Mahler, 435 8408.

Mon 9 General FNCV Meeting. Members night. Herbarium Hall 8 p.m.

Thurs 12 Botany Group Meeting. Publishing the Flora of Victoria - Neville Walsh. Herbarium Hall 8 p.m.

Sat 14 Fauna Survey Group Field Survey. Leadbeaters Possum Survey. Contact Ray Gibson, 874 4408.

Wed 18 Microscopy Group Meeting. Micro-fungi on Native Vegetation - Mary Cole. Astronomer's Residence 8 p.m.

Sat 28 Botany Group Excursion. Alpine Plants at Lake Mountain. Leader Dr. Malcolm Calder. Contact Joan Harry, 850 1347.

December

Tues 1 Fauna Survey Group Meeting. The Polar Dinosaurs of Victoria - Dr. Tom Rich. Herbarium Hall 8 p.m.

Sat 5 Fauna Survey Group Field Survey. Leadbeaters Possum Survey. Contact Ray Gibson, 874 4408.

Sun 6 General FNCV Excursion. Butterflies at Warrandyte. Leaders Pat and Mike Coupar. Contact Dorothy Mahler, 435 8408.

Thurs 10 Botany Group Meeting. The Biogeography and Adoptions of Australian Alpine Flora - Dr. Malcolm Calder. Herbarium Hall 8 p.m.

Mon 14 General FNCV Meeting. The Natural History of South Africa - Rosemary Balmford, RAOU. Herbarium Hall 8 p.m.

Sat 26 - Mon Jan 2 Fauna Survey Group Field Survey. Jilpanger Scrub Flora and Fauna Survey. Contact Felicity Garde, 808 2625.

Mrs. Enid L. Robertson — Medallionist for 1992

The Australian Natural History Medallion for 1992 has been awarded to Mrs. Enid L. Robertson, a distinguished botanist, ecologist and conservationist from Adelaide.

The award will be presented in Adelaide and we extend our congratulations to Mrs. Robertson.

The Victorian Naturalist



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Assistant Editors: Ed and Pat Grey

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ISSN 0042-5184

Cover Photo: Tasmanian Waratah, *Telopea truncata*, an endemic of Tasmanian mountains, by David Robinson.

Following the publication of the article 'Expansion of the Range of the Black Wallaby in Western Victoria' by P. R. Bird (The Victorian Naturalist 109(3): 89-91), Rod Bird received some correspondence from Brian Mitchell (Hon. Sec. Mt Gambier Field Naturalists Soc. Inc.) with further information on the subject. With permission, Mr Bird forwarded the correspondence and article to us to be published for our readers interest.

Range of *Wallabia bicolor*

I was interested to read your article concerning the range of the Swamp Wallaby, and the apparent expansion of its range into the Hamilton area. Your observations coincide with an increase of observations in the south-east of South Australia, and one wonders if there is indeed an increased population, a migration to previously unoccupied habitat, or perhaps a greater awareness on the part of an informed public?

The Australian Museum 'Complete Book of Australian Mammals' was probably already in the hands of the printers when the record for Mount Burr was confirmed by the late Peter Aitken in April 1982 and so missed recording. I enclose a copy of the local newspaper article which mentions a survey conducted by Keith Bellchambers for the Woods and Forest Department. However, it failed to produce other reliable evidence of Swamp Wallaby in the region.

However, since then there have been a number of reliable sightings: by Woods and Forests staff in the Honans Native Forest Reserve west of Mount Gambier, by a local farmer on several occasions in the same area, and by another (Mr. Bob Beck - mentioned in the article) at Mingbool on the Victorian border. Most recently a carcass was recovered from the Millicent to Beachport road near the turn-off to Southend, by the N.P.W.S. Ranger at Southend, Mr Ken Hein. The locality at this point is a complex of cleared land, dense semi-permanent and permanent swamp, and extensive thickets of *Melaleuca halimaturorum*. I understand Mr Hein is currently collating records of sightings for the N.P.W.S., should you be interested in comparing notes.

Irrespective of its absence from the Lower Glenelg National Park, I believe there is ample suitable habitat of mixed open/closed, seasonal swamp and heathland, ranging from the region between Mr. Gambier, Millicent and Penola/Naracoorte, and across the border to Casterton, thence north and south of Coleraine to link with Hamilton and the Grampians in the north, and Mr. Eccles/Heywood, Mt. Clay/Pallister Reserve in the south. But so far, it has not appeared in parks or gardens in and around Mr. Gambier, unlike Hamilton!

A further comment on the local situation from Barry Grigg (a technical officer with the Woods and Forests Department, currently engaged in finalising management plans for W.F.D. Native Forest Reserves in the South-east of South Australia) is that he regularly observes Swamp (black) Wallaby in western Victoria in the daytime in roadside vegetation when travelling to and from Lorne, but has never seen them in comparable situations in the south-east of South Australia.

Brian Mitchell

Border Watch 20.04.82

Rare Wallaby Found in SE

Forest Supervisor from Tantanoola Forest Reserve, Mr. Roy Lowndes, found a dead wallaby by the roadside near Mount Burr.

From his experience he recognised it as a Swamp Wallaby and this has been confirmed by the Curator of Mammals, Mr. P. Aitkens of the South Australian Museum.

Swamp Wallabies are common in eastern Victoria but the nearest populations to South Australia are at the western end of the Otway Ranges.

One dead animal was found in the Grampians recently but a colony of living animals has not been discovered there yet.

There is no sound historical evidence that these animals were widely distributed in western Victoria or have occurred in South Australian since settlement.

Local Naturalist, Mr. Bob Beck of Mingbool, has recently made reliable sightings of what may well be this animal but these observations have not been confirmed by capturing a live specimen.

In western Victoria these animals are known to be able to survive in small colonies in remnant patches of dense native vegetation surrounded by cleared land.

The area in which the carcass was found is a ideal habitat which may have allowed the wallabies to survive for such a long time undetected.

Swamp Wallabies may also have been confused with Red-necked Wallabies because they are very similar in size, shape and hopping motion.

The major difference is that they have a dark tail and a uniform dark grey body unlike the Red-necked Wallaby which has lighter fur with a red rump and neck.

If the colony of these animals can be found in South Australia it will be the first proven occurrence in South Australia and the most westerly extent of its range in Australia which will confirm anecdotal reports from early settlers.

Mr. Aitken of the South Australian

Museum has said that it is encouraging to realise that some of the native mammals that have been lost from the South East since settlement may still be surviving in isolated pockets of native vegetation.

Unless a colony of these animals can be found in the vicinity there is always the possibility that this animal may have escaped from a private sanctuary.

Some years ago a report of the extinct Toolache Wallaby in the South East was discovered to be observations of an Agile Wallaby which normally occurs in the tropical regions of Australia and which must have been an escapee from a sanctuary.

Survey

This year, Mr. Keith Bellchambers, a postgraduate student from Roseworthy College, received a grant from the Wildlife Conservation Fund to determine the distribution of mammals that are dependent upon the forest vegetation in the Lower South East Region.

The survey is being conducted in conjunction with the Woods and Forests Department and National Parks and Wildlife Service and will include visits to private landowners.

The animals he will be searching for are the Eastern Grey Kangaroo, the Short-nosed Bandicoot, the Red-necked Wallaby and the Yellow-bellied Glider which was only discovered last year by Mr. B. R. Grigg of the Woods and Forests Department.

With the recent discovery of the dead Swamp Wallaby by Mr. Roy Lowndes, this animal will also be included in the survey.

Update for 'Native Trees and Shrubs of South-Eastern Australia'

Since this book was first published in 1981, and revised in 1983, there have been many changes in botanical names, and numerous new species described.

For anyone wishing to incorporate the taxonomic changes into their own copies of the book, the author has produced an eight-page supplement of more than 100 amendments to botanical names, and over 60 brief descriptions of newly described species for the book's area.

Single copies of this supplement (which can be photocopied) may be obtained by sending a standard long envelope, **self-addressed and stamped (45c)**, to: Leon Costermans, Science Education, Monash University (Frankston Campus), Frankston, Victoria 3199.

Distribution and Range Reduction in Victoria of the Eltham Copper Butterfly *Paralucia pyrodiscus lucida* Crosby

M.F. Braby*, D.F. Crosby** and P.J. Vaughan***

Abstract

The geographic range of the Eltham Copper Butterfly, *Paralucia pyrodiscus lucida*, in Victoria is reviewed on the basis of historical records and from field surveys in 1987-88. The subspecies is recorded from eight localities but only three disjunct populations are now known to exist. The populations are fragmented and occur in mixed eucalypt woodland and open forest habitats of central and western Victoria in which the mean annual rainfall varies from 420-750 mm. Habitat loss, through extensive agriculture and urbanisation, is implicated as the main factor for the loss of known populations. Preliminary observations on the male hindwing phenotype suggests *P. p. lucida* may form part of an extensive coastal-inland cline with populations in New South Wales and central Queensland. Despite taxonomic difficulties the Victorian populations, as currently defined, should be regarded as vulnerable.

Introduction

The Eltham Copper Butterfly, *Paralucia pyrodiscus lucida* Crosby (Lepidoptera: Lycaenidae) (Fig. 1), is currently regarded



Fig. 1. Male Eltham Copper Butterfly *Paralucia pyrodiscus lucida* near Melbourne. Photo: M.F. Braby.

as a subspecies or geographical race of the Dull Copper Butterfly, *Paralucia pyrodiscus pyrodiscus* (Doubleday), (nomenclature of Edwards 1991). The species is uncommon but widely distributed in eastern and southeastern Australia (Common and Waterhouse 1981). The nominate subspecies occurs from central Queensland (Bauhinia Creek 10km E of Boolburra, 23°44'S, 149°47'E, near Duaringa; Expedition Range; Kroombit Tops) (Atkins 1974, 1976, Monteith and Yeates 1986) to eastern Victoria (Nowa Nowa, 37°44'S, 148°05'E, near Lakes Entrance) (Crosby 1951a, b), and as far inland as Mount Moffatt National Park in central Queensland (Monteith and Yeates 1988) and Warrumbungle National Park in central New South Wales (Daniels and Moulds 1977). More recently, it has been collected farther north at 11km WNW of Herberton (17°20'S, 145°17'E) at 750 m on the Atherton Tablelands in north-eastern Queensland (Wood 1992), and E.D. Edwards captured four males at Kenebri Salt Caves (30°45'S, 149°17'E) in the Pilliga Scrub of inland New South Wales on 22 October 1989 (specimens lodged in Australian National Insect Collection). The early reference to Bowen, northern Queensland, by Waterhouse (1903), may have been documented in error as the locality was not listed in subsequent works (Waterhouse and Lyell 1914, Waterhouse 1932, Common and Waterhouse 1972, 1981). By contrast, *P. p. lucida* is much more restricted in distribution being geographically separated, known only from central and western Victoria (Crosby 1951a, Common and Waterhouse 1981), and is currently threatened (New 1991, Braby and Crosby, in press).

The purpose of this account is to provide an historical overview of the distribution and occurrence of *P. p. lucida*, to speculate on which factors have led to its decline and briefly describe its habitat

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** 74 Gipps Street, East Melbourne, Victoria, 3002.

*** Shire of Eltham, P.O. Box 21, Eltham, Vic. 3095.

preference. This treatment is essential for establishing precise distributional data for a species which is poorly represented in the state as a whole. Moreover, the early records give some indication of causal factors contributing to local extinction and population contraction. We also discuss problems associated with the variation and taxonomic status. We build on, rather than recapitulate, information in two previous reports (Crosby 1987, Vaughan 1988).

Methods

Information on geographical distribution was collated from four main sources: (a) published records, (b) label data from specimens held in the Museum of Victoria, Melbourne (MVM), Australian National Insect Collection, Canberra (ANIC), Australian Museum, Sydney (AMS), Queensland Museum (QM), James Cook University, Townsville (JCU) and the British Museum (Natural History), London (BMNH), (c) from observations made by collectors and naturalists, and (d) field surveys. All localities from which the species was known, and some intervening areas, were examined by the authors between November 1987 and February 1988. Overall, 219 sites distributed throughout the Melbourne, Wimmera, Ballarat and North-central regions of Victoria were assessed for the presence of the butterfly. Survey effort was based primarily on the occurrence of the known preferred habitat, identified from vegetation maps (from Land Conservation Council reports) and from the Melbourne Flora Survey Unit records, as well as on the distribution of the particular form of the host plant, *Bursaria spinosa* Cav. (Pittosporaceae) (Braby 1990). Sites identified by members of the public in response to media reports requesting residents to check for butterfly colonies on their properties were also examined.

Variation and taxonomic status

The main criterion used for separating the two subspecies was based on the extent and variability of copper scales on the

hindwing upperside of males. *P. p. lucida* was considered to have a consistent and well defined bright patch of coppery scales, whereas *P. p. pyrodiscus* had an ill-defined (i.e. dull) central copper area often reduced to only a mere suffusion of copper scales, with the extent of the copper area being individually variable (Crosby 1951).

The distribution of the two subspecies, however, has met with some difficulty. McCubbin (1971) suggested that *P. p. lucida* was a distinct race confined in its entirety to the north-eastern suburbs of Melbourne. While acknowledging that specimens from Kiata and Dimboola in western Victoria may belong to this race, he nevertheless placed them under *P. p. pyrodiscus*. Common and Waterhouse (1972, 1981), however, in a more formal treatment of the species, later assigned these specimens, to *P. p. lucida*. Atkins (1974, 1976) also expressed opinion that material taken from the Expedition Range, central Queensland, was better placed with "*lucida*" than with coastal populations of the typical race, but this was not accepted by Common and Waterhouse (1981).

During the course of collecting distributional data from material held at ANIC, AMS, MVM and QM, these disparities in opinions became even more apparent. Waterhouse (1903) first noted that *P. pyrodiscus* was a variable butterfly, and this was particularly evident amongst northern populations. For example, a number of *P. p. pyrodiscus* specimens from localities in New South Wales and Queensland exhibited a degree of hindwing copper scaling which was best described as "intermediate" between the very bright specimens from Melbourne (Eltham, Greensborough) and the very dull examples from eastern Victoria (Nowa Nowa, Mallacoota). In some areas in New South Wales (e.g. Sydney district, Menangle Park, Mulgoa, Armidale) and Queensland (e.g. Glen Aplin, Kroombit Tops) males from the same locality resembled either of these two forms. Moreover, males from the more inland areas (Qld.-Mount Moffatt National Park, Eidsvold, Millmerran, Stanthorpe; N.S.W. Pilliga Scrub) approached *P. p.*

lucida, while the typical dull specimens were largely confined to moister coastal areas from south-eastern Queensland through New South Wales to eastern Victoria. Material taken recently from Expedition Range (Blackdown Tablelands), inland central Queensland, by M.F. Braby indicated that males from this locality more closely conformed to the dull coastal examples from Brisbane and farther south. Specimens from Herberton, north-eastern Queensland, however were distinctive, being considerably darker above (especially in females) compared with any other known populations, and this population perhaps warrants recognition as a distinct ecological form or even subspecies.

Geographic distribution

The distribution of *P. p. lucida*, together with *P. p. pyrodiscus* in Victoria, is shown in Figure 2. *P. p. lucida* was recorded from eight locality areas in central and western Victoria. However, populations no longer existed at five of these localities (Table 1) and the subspecies geographic range has almost certainly contracted, now confined to three disjunct areas. These populations were very fragmented and the constituent colonies occurred in very small isolated habitat blocks. No new localities were revealed from our survey, but one

population was rediscovered. Remnant habitat blocks, which have not been exhaustively surveyed, occurred between the known populations (e.g. Bendigo-Heathcote district) and it is possible that continued searching may yield additional sites.

Past records

(a) Goulburn Valley (Tallarook). The first Victorian record for *P. pyrodiscus* was from the "Goulburn Valley" region. Anderson and Spry (1893-94) stated that "...it has been found to occur freely in the Goulburn Valley..." but gave no precise locality details or dates. The only specimens which confirm this record are two males labelled "Goulburn Valley, Feb. 1893, Meyrick Collection" (BMNH); one specimen had an additional label "JAK". The specimens were apparently taken near Tallarook (37°06'S, 145°06'E) in the vicinity of the Goulburn River in central Victoria (A.N. Burns, pers. comm. 1989). It is unlikely that the butterflies were taken by Meyrick (P. Ackery, pers. comm.) and were probably collected by G. Lyell (who later gave them to Meyrick) and identified by J.A. Kershaw (K. Walker, pers. comm.). Burns felt that E.

Table 1. Locality records for which *Paralucia pyrodiscus lucida* is presumed extinct. MVM = Museum of Victoria (Melbourne), AMS = Australian Museum (Sydney), ANIC = Australian National Insect Collection (Canberra), BMNH = British Museum, Natural History (London).

Locality	Date	Collector	Source	No. of Specimens	
				male	female
Goulburn Valley	Feb. 1893	J.A. Kershaw (Meyrick Coll.)	BMNH	2	
Goulburn Valley	—	—	Anderson & Spry (1893)		
Munroa	1906	J.A. Hill	K. Hatley (pers. comm.)		
Dimboola	20 Nov. 1907	G.A. Waterhouse	AMS	7	
Dimboola	20 Nov. 1907	G. Lyell	MVM*		1
Dimboola	Nov. 1907	—	Waterhouse & Lyell (1908)	12	
Kelso	30 Dec. 1920	L.B. Thorn	MVM	3	
Broadmeadows	7 Jan. 1922	A.N. Burns	AMS	2	2
Broadmeadows	7 Jan. 1922	A.N. Burns	A.N. Burns (pers. comm.)	8	6
<i>Total</i>				34	9

* The labels do not show the name 'G. Lyell' but the writing is clearly that of George Lyell.

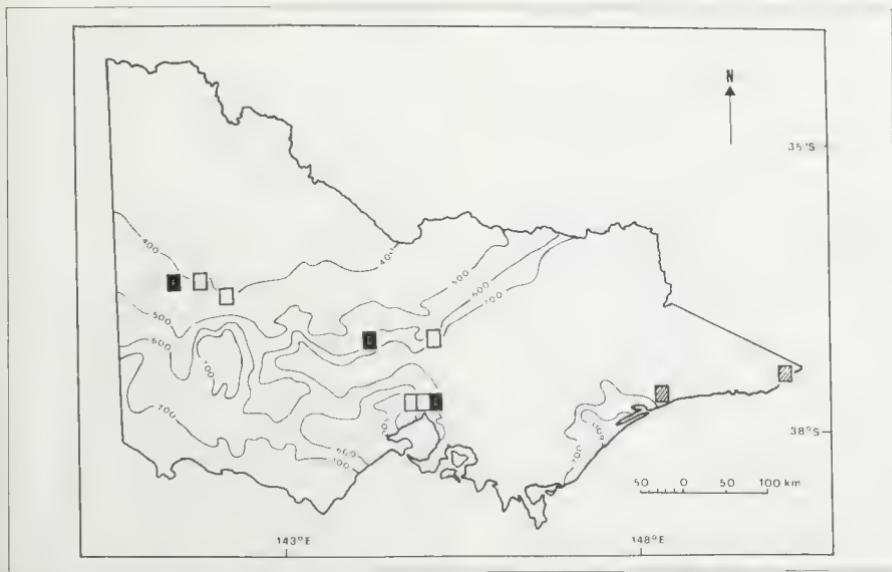


Fig. 2. Distribution of *Paralucia pyrodiscus* in Victoria: ssp. *lucida* (present occurrence (■) and presumed extinct (□) and ssp. *pyrodiscus* (▨). Mean annual rainfall isohyets 400-700 mm are shown (from Lee 1982). All localities are plotted on 10'x 10' grids.

Anderson and F.P. Spry also collected the species from the same area around 1893, just prior to publication of their book. The absence of any further records for almost 100 years from this well collected area suggests the species is now extinct in the region.

(b) Murtoa. Specimens of *P. p. lucida* were apparently collected "adjacent to the railway line" near Murtoa (36°37'S, 142°29'E), around 1906-07 by the late J.A. Hill of Kewell (K. Hateley, pers. comm. 1987). There are no other records and the original specimens could not be traced. Little natural vegetation remains in the area and the species must now be presumed locally extinct.

(c) Dimboola. The Museum of Victoria and the Australian Museum hold twelve and eight specimens respectively, which were collected on 20 November 1907 at Dimboola (36°27'S, 142°02'E) during an expedition by G.A. Waterhouse, G. Lyell and Frichot (see Waterhouse and Lyell 1908). Again, this is the only record for

the locality. We were unable to find any colonies or suitable habitat and the species is almost certainly extinct in the area.

(d) Keilor. The only record for Keilor (37°43'S, 144°50'E) is five specimens labelled "Keilor, 30 Dec. 1920, L.B. Thorn" (MVM). The butterflies were collected near the Maribyrnong River in a "small open grassy area with some stunted bursarias, now given way to vegetable growing" (A.N. Burns, pers. comm. 1989). A concentrated search along the Maribyrnong River where some remnant but degraded vegetation occurs yielded few bursarias but no butterfly colonies (much of the natural habitat in the district has been removed for agricultural purposes). With increased development and urbanisation over the past 70 years the species must now be considered locally extinct.

(e) Broadmeadows. Sixteen specimens (2 in AMS; 14 in A.N. Burns' private collection) were collected at

Broadmeadows (37°40'S, 144°55'E) by A.N. Burns on 7 January 1922. The specimens were taken "within 100-300 yards due west of the railway station where some small stunted bushes of *Bursaria* occurred" in an area "where the Leisure Centre and Community Health Centre now stand" (A.N. Burns pers. comm. 1988). Intensive searches along the banks of the Moonee Ponds and Yurokee Creeks where some scattered plants of *B. spinosa* occur yielded no butterflies. Much of the area is urbanised, and remaining unbuilt areas are heavily weed infested and degraded. The species must now be considered extinct in the district.

Present records

(f) Castlemaine. Billinghamurst (1895) and Waterhouse and Lyell (1914) made references to Castlemaine (37°05'S, 144°13'E). The only early specimens, however, are one female labelled "Castlemaine, Vic., 20 Nov. 1907, Dr. Drake Collection" (ANIC) and one male labelled "Castlemaine, Vic., 10 Dec. 1907, Dr. Drake Collection" (ANIC). In December 1987, the Castlemaine population was rediscovered after it had apparently not been recorded for over 80 years: a small colony was found persisting in the same area (Crosby 1989). This is the only colony known to exist in the district.

(g) Kiata. Six colonies currently occur at Kiata (36°22'S, 141°48'E) and a seventh occurs nearby at Salisbury. Early documented records were given by Crosby (1951a, 1965), Tindale (1953) and McCubbin (1971), although the population had been known to exist since the early 1930's (K. Hateley, pers. comm. 1987). A number of specimens collected during the 1950's and early 1960's by K. Hateley, D.F. Crosby, F.E. Parsons, F.E. Wilson, J.M. Landy and G. Forbes are lodged in MVM and ANIC.

(h) Eltham, Greensborough. Colonies of *P. p. lucida* from the type locality near

Melbourne (Eltham-Greensborough district, around 37°43'S, 145°10'E) have received more attention than all other populations of the species. The earliest record is two male specimens (lodged in MVM) taken by F.E. Wilson at Eltham on 26 December 1939. Subsequently, a large number of specimens (held mostly in MVM, ANIC and JCU) were collected during the 1940's and 1950's by F.E. Wilson, A.N. Burns, J.C. Le Souef, D.F. Crosby, C.W. McCubbin, W.N.B. Quick, J.M. Landy and E.J. Harris. There are also three male specimens in BMNH labelled "Eltham, 6 Jan. 1957, H. Borch".

In 1971, Charles McCubbin warned that: "This race may soon become extinct since the restricted area (Eltham, Greensborough) where it is found is being developed for housing" (McCubbin, 1971). Between 1958 and 1981 no specimens of *P. p. lucida* were registered in scientific collections, although positive sightings were made by several local naturalists during this period. D.F. Crosby noted the butterfly as "common" on 25 January 1958, and B. Vardy (pers. comm. 1987) recorded the species at Eltham in 1972. On 31 January 1977, I.D. Endersby (pers. comm.) noted a colony at Montmorency (near Eltham), and he recorded subsequent sightings of butterflies. A colony, believed to be *P. p. lucida*, was located by C. Beardsell (pers. comm.) in 1982 at Yarrambat, approximately 9 km NNE of Greensborough. Beardsell later expressed concern about its likely future (Pugh *et al.*, 1983), the colony was subsequently destroyed by horses grazing the larval host plants. However, as no specimens were collected, the record needs confirmation: the butterflies observed may in fact have been *P. aurifera* (Blanchard) (bright copper) with which *P. p. lucida* could be confused easily.

Intensive searches by D.F. Crosby in the Eltham-Greensborough district during 1979-81 yielded no butterflies: many of the colonies from which specimens were originally collected during the 1940's and

1950's were eliminated by housing development. However, on 10 January 1982, a large but remnant colony was discovered in a bushland reserve at Greensborough (7 males lodged in ANIC). On 14 January 1986 M.F. Braby located a small remnant colony within a bushland reserve in the Eltham area. A further five colonies were subsequently located (Crosby 1987, Vaughan 1988), bringing the total known reservoir of extant colonies in the Eltham-Greensborough district to eight.

Habitat preferences

The three remaining populations of *P. p. lucida* occurred in a variety of eucalypt woodland and dry open forest formations in which the understorey usually comprised a diverse array of native shrubs, herbs and grasses (Fig. 3). Within such sites the butterfly was very localised in extent, showing a marked preference for the drier, more open grassed microhabitats in which scattered stands and patches of the

diminutive form of the host plant *Bursaria spinosa* occurred. This localised distribution pattern was exemplified by colonies at Eltham-Greensborough where most colonies occurred on well drained elevated areas, usually on gentle slopes and ridges (often of northern aspect) adjacent to moister gullies with dense stands of the host plant. At Kiata, the colonies were on very gently sloping terrain with an overstorey of *E. largiflorens* F. Muell., *Allocasuarina luehmannii* (R. Baker) L. Johnson and some *E. leucoxylon* F. Muell. and *Callitris preissii* Miq. Further details on plant composition and vegetation structure are given by Vaughan (1988).

Discussion

Information presented on the geographic distribution of *P. p. lucida* suggests the subspecies has suffered extensive range contraction. At least five populations have knowingly become extinct during the past century, *viz*: Goulburn Valley (Tallarook), Murtia, Dimboola, Keilor and Broadmeadows; the remaining populations at the three known localities essentially represent relics of a taxon which undoubtedly was once locally common and more widespread. The subspecies now comprises a total of only sixteen colonies and its conservation status is vulnerable (Braby and Crosby, in press).

From the few records available it is difficult to assess the subspecies distribution and habitat requirements in detail. Prior to European settlement *P. p. lucida* was probably widespread, but localised, with populations restricted to areas of gentle sloping terrain in the foothills and plains of the Great Dividing Range which receive a mean annual rainfall of at least 420 to 750mm. The species clearly penetrated the now extensive 'wheat belt' inland of the Divide. Colonies at Eltham-Greensborough near Melbourne probably represented a disjunct population which occurred in similar habitat south of the Divide. The Keilor and Broadmeadows populations were probably restricted to woodland vegetation which once prevailed along gorges and sloping banks of stream



Fig. 3. Open forest habitat of *Paralucia pyrodiscus lucida* at the type locality Eltham - Greensborough showing *Eucalyptus macrorhyncha*, *E. goniocalyx* and *E. melliodora* overstorey. Photo: M.F. Braby.

valleys where the host plant occurred (Willis 1964) rather than on the basaltic grassland plains. Existence of colonies in the same sites at Kiata and Castlemaine for more than 50 and 90 years, respectively, indicate that populations are sedentary.

The cause of decline and factors contributing to the butterflies' rarity are largely unknown, they can only be implied from recent changes caused since European settlement. Nutritional constraints may mean that some lycaenid butterflies are very spatially patchy in distribution (Smiley *et al.* 1988) but this alone could not account for the extreme paucity of records. The major compounding factors appear related to habitat loss and urbanisation, both of which have contributed to substantial population decline and extinction for a number of rare lycaenid butterflies elsewhere in the world, for example, *Lycaena dispar* *dispar* Haw. in Britain (Dufsey 1977), *Icaricia icarioides missionensis* near San Francisco, California (Orsak 1982) and *Plebejus argus* L. in Britain (Heath *et al.* 1984, Ravenscroft 1990). We suggest that habitat destruction through agriculture, particularly in areas north of the Great Divide (i.e. the wheat belt); urbanisation, especially where populations occurred near Melbourne; and possibly gold mining (and associated soil disturbance to host plants, larvae and attendant ant colonies), such as that which occurred in the Castlemaine district (Forster 1971), have adversely affected the status of *P. p. lucida*. Almost 60% of the original cover of forests and woodlands in Victoria has been cleared, largely for agricultural purposes (Frood and Calder 1987, Woodgate and Black 1988). Greatest habitat modification occurred in those areas most suitable for grazing, particularly in the Western, Wimmera and Northern plains - the region apparently most favoured by *P. p. lucida*. The extent to which *P. p. lucida* tolerates such large scale clearing and habitat disturbance presumably is very poor. This appears in contrast to northern populations of *P. p. pyrodiscus* which may thrive well in regularly disturbed open country, provided the larval host plants are

not depleted (A. Atkins pers. comm. 1992).

Preliminary morphological observations made on the male hindwing phenotype over the species broad geographic range clearly indicate that *P. pyrodiscus* is variable and further detailed study is required to examine this pattern of variation and to establish how much variability is attributed to environmental factors and genotype. It may be a long time before this is fully resolved, and until such time the subspecies *P. p. lucida* must at present be treated as a distinct taxon at risk in which the known populations are localised, geographically separated and biologically isolated by loss of intervening habitat. They thus provide an interesting example for studies of evolution and processes of speciation, and at very least, they merit strong conservation concern (New 1991).

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Butterflies at Yarra Bend 1983-90

Ian Faithfull*

Abstract

Observations of 16 species of butterfly (Lepidoptera) at Yarra Bend Park, Melbourne, Victoria, from 1983 to 1990 are summarised. *Tapezites symmomus soma* Waterhouse and *Geitoneura klugii klugii* (Guer.) are considered the most significant. Two species, *Geitoneura acantha oerea* (Guer.) and *Ogyris olane ocelia* Waterh. have probably disappeared from the reserve in the last 100 years. A list of nine further species likely to be found at Yarra Bend is provided.

Introduction

Natural bushland can be found no closer to the GPO Melbourne than at the Yarra Bend Park, four kilometres north east of the city centre. The 223 hectare reserve, managed by the Yarra Bend Park Trust (YBPT) on behalf of local councils, includes seven kilometres of winding river, the lowest reaches of the Merri Creek, two golf courses, unusual geology, and increasing areas of re-created bushland. Studley Park is incorporated within it. Little is known about the invertebrate fauna of the Park and no insect species were mentioned in the recent Draft Management Plan (YBPT, 1990).

During the years 1983 to 1988 I lived not far from the reserve and during many visits recorded details on the butterflies observed. Areas covered were from the Walmer Street footbridge and the Dickinson Reserve (not strictly part of the Park) in the south, to Collins Footbridge and the Hall Reserve (along Merri Creek) in the west, to the Eastern Freeway bridge over the Yarra in the north east. Much of my time was spent in the area bounded by Studley Park and Boathouse Roads and the Yarra River. Sixteen species were recorded during this period.

My observations were mainly of adult insects. I never carried a butterfly net. Nor did I search foodplants for immature

stages, or seek pupae of *Ogyris* or other lycaenids under bark, such activity being essential for a thorough butterfly survey. Nevertheless the list presented below forms a basis for further studies.

Grid references of sightings from the 'Melway Street Directory', map 44, are given for various species. Although this form of mapping may be of little worth to future workers I am unable to precisely relocate many observations and overlay them on a standard grid. Melway grid squares are approximately 388 m (east-west) by 407 m, and run A to K west to east, and 1 to 12 north to south. The north west corner of grid square G3 closely corresponds with the Australian Map Grid reference Yarra 3 24 58 15.

The months during which a species was seen are also recorded; no observations were made from March to July.

Two further lists are presented: species that have disappeared from the area and those which may occur there but have yet to be recorded.

Terminology follows Common and Waterhouse (1981) for butterflies and Willis (1970, 1972) and Forbes and Ross (1988) for plants.

Current Species List

Tapezites symmomus soma Waterhouse. *Symmomus* Skipper.

Andrew Atkins (pers. comm.) captured a male at Studley Park on 27 February 1959 "on bushes, Yarra" the precise locality being unrecorded. In 1987 Michael Braby (pers. comm.) found larvae in the area southeast of Dights Falls where its foodplant, Spiny-headed Mat-rush, *Lomandra longifolia* Labill., occurs in dry sclerophyll shrubland on steep banks. *Dispar compacta* (Butler). *Dispar* Skipper.

Braby (pers. comm.) also found this species. I have found it in large (20 hectare plus) gardens in central Melbourne (Botanic Gardens, Fitzroy Gardens,

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Fawkner Park) where it is never numerous, and smaller gardens in surrounding suburbs (e.g. Hawthorn). K. Dunn (pers. comm.) and I have seen it recently at Burnley.

Taractrocera papyria papyria (Boisduval). White Grass Dart.

This small skipper, whose larvae feed on various grasses, seems to have suffered from competition with the larger, invasive *Ocybadistes walkeri* which seems to displace it (Morton, 1985; K. Dunn, pers. comm.; personal observations). November to February. G4,G5.

Ocybadistes walkeri sothis Waterhouse. Yellow-banded Dart.

First noted at Yarra Bend in November 1983 (Faithfull, 1985). During the 1980s this butterfly extended its range through much of the Melbourne metropolitan area probably as a result of accidental introduction in instant lawn consignments, i.e. in turves, from New South Wales and northern Victoria. The weed grasses Kikuyu, *Pennisetum clandestinum* Hochst. ex Chiov. and *Ehrharta erecta* Lam. are preferred larval food plants (Crosby and Dunn, 1989) and both are widespread in the Park. November to February. G4,G5,H4,H5.

Papilio anactus W.S. Macleay. Dingy Swallowtail.

Larvae on cultivated citrus in Victoria. There is an early specimen in the Australian National Insect Collection collected at Burnley in January 1935 by R.T. Pescott (L. and K. Dunn database). Common in some Melbourne suburbs, including Camberwell, since about 1973. Sighted in January 1985 flying around the ridge south of Dights Falls. P. Lynch (pers. comm.) saw it in 1988 west of the Pipe Bridge (Fairfield Park). Larvae on a lemon tree at Abbotsford in 1989. January. G4. *Delias harpalyce* (Donovan). Imperial White.

Larvae and pupae on Creeping Mistletoe, *Muellerina eucalyptoides* (D.C.) Barlow, on River Red Gum, *Eucalyptus camaldulensis* Dehnh. in 1984. May (larvae), October (pupae). J2.

Anaphaeis java teutonia (Fabricius). Caper White.

Migrant, presumably from inland New South Wales. Most frequently seen in late October and in November when large flights may pass through Melbourne. Its food plants do not occur naturally in Victoria. October to December.

Pieris rapae rapae (Linnaeus). Cabbage White.

Introduced to Australia in the 1930s and a recognised pest of crucifers (Brassicaceae). Common all areas. August to February.

Geitoneura klugii klugii (Guerin-Meneville). Klugs Xenica.

See figure 1. A single specimen was observed on 1 January 1985, just south of where Studley Park Road crosses over the Boulevard, in Golden Wattle, *Acacia pycnantha* Benth., scrub. A common butterfly in southern Australia which rarely survives in the suburbs of Melbourne. Weeping Grass, *Microlaena stipoides* (Labill.) R.Br. has been recorded as a food plant near Melbourne (Braby, pers. comm.) and is present and common in the park (McIntyre and Yugovic, 1982; Lynch, pers. comm.). Of the grasses recorded as food plants by Common and Waterhouse (1981), Kangaroo Grass, *Themeda triandra* Forssk. (= *australis* (R.Br.)) and Tussock Grass, *Poa australis* spp. agg. are recorded from the Park (McIntyre and Yugovic, 1982) and in some places are abundant (e.g. top of ridge G4). However Braby (pers. comm.)

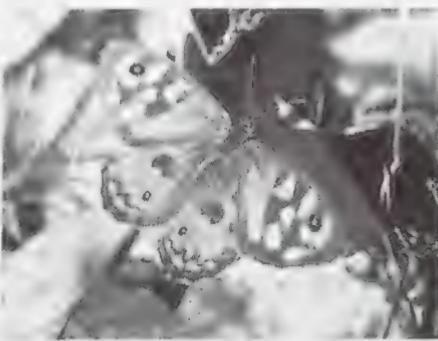


Fig. 1. Klugs Xenica, *Geitoneura klugii klugii*, a common butterfly in southern Australia but now rare at Yarra Bend. Photo: I. Faithfull

ridge G4). However Braby (pers. comm.) and others consider these host records as unreliable. Wallaby grass, *Danthonia*, is a preferred host in parts of Gippsland and ten *Danthonia* species have been recorded from the Park (YBPT, 1990). Braby and New (1988a,b) investigated the biology of Klugs Xenica near Melbourne. *Heteronympha merope merope* (Fabricius). Common Brown.

McCubbin (1971) noted that this is the only brown to adapt to the suburban environment in south-eastern Australia. It is sometimes the commonest butterfly in inner Melbourne. Native grasses *Themeda* and *Poa* are recorded as foodplants (Common and Waterhouse, 1981) as well as *Ehrharta erecta* in Melbourne suburbs (Pearse, 1978). Native tussock grasses *Poa labillardieri* Steudel, *P. morrisii* Vick. and *P. sieberiana* Springel occur in the Park and *E. erecta*, recognised as an environmental weed at Yarra Bend (YBPT, 1990), is widespread. Common at Studley Park and wherever there is long grass. October to February. G4, G6, J5, K3, K5. *Vanessa kershawi* (McCoy). Australian Painted Lady.

Common at times. Food plants recorded by Common and Waterhouse (1981) and found in the Park are Sticky Everlasting, *Helichrysum viscosum* Sieber ex Spreng. (*H. bracteatum* (Vent.)) and the exotics, Capeweed, *Arctotheca calendula* (L.) M. Levyns and Wormwood, *Artemisia* sp. (YBPT, 1990). I have seen this butterfly fly up to defend territory against seeds falling from an Elm tree, *Ulmus* sp. August to February. F3, G3, G4, K1, H5. *Vanessa itea* (Fabricius). Australian Admiral.

Larvae feed on the native Scrub Nettle, *Urtica incisa* Poir. which occurs at Yarra Bend (YBPT, 1990) and the introduced Small Nettle, *Uurens* L., common at the Collingwood Childrens Farm. At Yarra Bend I have seen it feeding at flowers of Smooth-barked Apple *Angophora costata* (Gaertn.) Druce, and watched as it repeatedly moved its perch up a tall cypress tree to another sunlit spot nearer the top as shadows lengthened in late afternoon.

It was common in December 1990 on river flats beside the Merri Creek at Westfield Reserve (P. Lynch, pers. comm.). September to January. F3, G4, F5, J5. *Junonia villida calybe* (Godart). Meadow Argus.

Usually far less common in Melbourne than the Painted Lady which may look similar in flight. Larvae feed on plantains, *Plantago* spp., and several other plants. Never common at Yarra Bend and seen only at Dights Falls and 0.5 km to the north east. The Meadow Argus is usually more common in southern Victoria in March and April (K. Dunn, pers. comm.). End of August, February. F3, G4. *Nacaduba biocellata biocellata* (C. and R. Felder). Double-spotted Lineblue.

Adults were abundant on 8 December 1985 on the ridge to the south of Dights Falls with many in flight over the tops of trees and around tall shrubs of Golden Wattle, *Acacia pycnantha* and Silver Wattle, *A. dealbata* Link. Some were noted feeding at flowers of *Cotoneaster glaucophyllus* Franchet and a copulating pair was seen head downwards on the top of a dead *Acacia* shrub. On other occasions seen feeding at flowers of Lightwood, *Acacia implexa* Benth. and Prickly Box, *Bursaria spinosa* Cav. Larvae are *Acacia* feeders. November to February. G4.

Lampides boeticus (Linnaeus). Pea Blue. Uncommon. Larvae are legume feeders. December, January. G4.

Zizina labradus labradus (Godart). Common Grass Blue.

The commonest of the blues around Melbourne. The larvae probably feed mostly on clovers, *Trifolium* spp. October to February. G4, G6, J6, H3, K1.

Species that may have disappeared

There are no known extinct Australian butterfly species and there are few documented cases of local butterfly extinctions in this country (New, 1987). The following examples are therefore of particular interest.

Geitoneura acantha ocrea (Guest). Eastern Ringed Xenica.

Anderson and Spry (1893) stated that its "headquarters near Melbourne is Studley Park" so it was once a feature of the Yarra Bend fauna. Common and Waterhouse (1981) reported *Themeda triandra* as a foodplant of the larvae although Braby (pers. comm.) considers *Microlaena stipoides* to be the foodplant near Melbourne. Although the butterfly appears to be locally extinct both these foodplants are not. Braby and Berg (1989) suggested that *acantha* is more ecologically specialised and vulnerable to disturbance than *G. klugii*. Declining abundance of natural food plants and microhabitat through weed invasion, frequent mowing, etc. have probably led to its disappearance.

Ogyris olane ocela Waterhouse. Olane Azure.

Anderson and Spry (1893) recorded this Azure from Studley Park. Its known larval foodplants *Amyema* spp. mistletoes did not appear on the plant lists of McIntyre and Yugovic (1982) and Willis (1984), but *A. pendulum* (Sieber ex Sprengel) Tieghem is on the latest botanical inventory (YBPT, 1990) and there are specimens on trees close to the loop in Yarra Bend Road (H4) (Lynch, pers. comm.). This butterfly is not uncommon in Victoria and it is possible that it continues to exist in the Park.

Species which may occur

The presence of more observers over a longer time frame will result in additional records of butterflies that are uncommon or rare vagrants, and more skillful and intensive searching will lead to the discovery of further cryptic and inconspicuous species. The following butterflies are suggested as likely additions. Several other skippers (Hesperiidae), particularly *Hesperilla* and *Trapezites* species, and blues (Lycaenidae) could easily occur in the Park.

Eurema smilax (Donovan). Small Grass Yellow.

Rare migrant in Melbourne. The closest locality record appears to be Kew, where it was recorded in 1880 by F.G.A. Barnard (Anderson and Spry, 1893).

Delias aganippe (Donovan). Wood White.

Anderson and Spry (1893) considered it "common everywhere" but according to McCubbin (1971) "around Melbourne they are seldom common and numbers vary greatly from year to year. Although it has been an uncommon vagrant in Melbourne for many years, sightings in the inner suburbs of Melbourne have declined since 1965 (personal observations) and the species is now rarely seen. Recently recorded at Burnley (Braby and Dunn, pers. comms.) and Hawthorn (personal observation). Larvae are mistletoe, *Amyema* spp. and ballart, *Exocarpos*, feeders so there is potential for vagrants to breed in the Park.

Danaus plexippus plexippus (Linnaeus). Wanderer.

Uncommon vagrant. I have recorded it at Fitzroy Gardens (East Melbourne) and Camberwell.

Danaus chrysippus petilia (Stoll). Lesser Wanderer.

Uncommon vagrant. I have records from South Yarra and Camberwell.

Polyura pyrrhus sempronius (Fabricius). Tailed Emperor.

Rare vagrant. Seen at Heidelberg in March 1974 (Quick, 1974). Recently recorded at Burnley (Faithfull, 1990). Probably breeds in northern Victoria and intermittently near Melbourne.

Hypochrysops delicia delos (Waterhouse and Lyell). Blue Jewel. This species is of "very local" occurrence and is "extremely inconspicuous" in flight (Common and Waterhouse, 1981). The larval foodplants are *Acacia* species. Braby (1989) discussed its occurrence at LaTrobe University, Bundoora.

Ogyris abrota Westwood. Dark Purple Azure.

Almost certainly occurs at Yarra Bend. McCubbin (1971) recorded it from Richmond Park, about 2.5 km south of the southern section of Yarra Bend and a breeding population currently occurs along the banks of the Yarra at Richmond and Burnley (Braby, Dunn, pers. comms.). Ross Field (pers. comm.) reared specimens from *E. camaldulensis* beside the river between Swan Street and Bridge Road in 1974. Two

specimens in the Australian National Insect Collection taken by Andrew Atkins and labelled "Studley Park, Burnley, Vic" (18 Mar. 1975 and 28 Sept. 1977) (data from K. and L. Dunn database) were almost certainly collected in the same area near Burnley Oval as the records cited above (Atkins, pers. comm.). Hunting (1986) recorded it from Royal Park, about 8 km to the west of Yarra Bend. *Muellerina eucalyptoides* is the larval food plant and this mistletoe grows commonly on River Red Gum and on introduced ornamental trees including elm, birch and oak in inner suburbs of Melbourne (Nigel Quick, Common and Waterhouse, 1981; pers. observations).

Candalides hyacinthinus hyacinthinus (Semper). Common Dusky Blue.

Larvae of this widespread species feed on Dodder-laurels, *Cassytha* spp. Coarse Dodder-laurel *C. melantha* R.Br. is known from the Park (McIntyre and Yugovic, 1982; YBPT, 1990) including grids J5 and K4.

Theclinesthes serpentata serpentata (Herrich-Schaffer). Chequered Blue.

I have recorded single specimens from South Yarra and Burnley. Four of its known food plants occur in the Park: the natives Saloop, *Einadia hastata* (R.Br.) A.J. Scott, Nodding Saltbush, *E. nutans* (R.Br.) A.J. Scott and Berry Saltbush, *Atriplex semibaccata* R.Br., and the introduced Fat Hen, *Chenopodium album* L. (YBPT, 1990).

Discussion

The value of the remnants of natural vegetation at Yarra Bend is belatedly being recognised and their conservation now seems more secure (YBPT, 1990). Butterflies are heavily reliant on vegetation for their survival and the degradation of it at Yarra Bend has possibly led to the loss of two species. Of those that remain, the species of most interest are Klugs Xenica and the Symmomous Skipper, the records of which are the closest localities known to central Melbourne. Both are intimately dependent on the surviving fragments of

native vegetation. The sighting of a single specimen of *G. klugii* is not enough evidence to suggest the existence of an isolated breeding population, since females can disperse reasonable distances (Braby and New, 1988a, b), but it does suggest potential for re-establishment if no local breeding occurs. The *T. symmomous* colony is an important isolated remnant population (Braby, pers. comm.).

The remaining species, with the exceptions of the uncommon Wood and Imperial Whites, Meadow Argus and Double-spotted Line-blue, are widespread and frequently seen in central Melbourne and may be referred to as the inner Melbourne assemblage. They form a distinctive suite of butterflies able to exist in the high density residential, commercial and industrial areas of the inner city because they can breed on introduced plants, or are vagrants and migrants.

This list of Yarra Bend butterflies is a basis for future comparison. The disappearance of any further indigenous species will imply continued deterioration of vegetation communities. Conversely, the fauna, especially the more sensitive resident breeders, have an important role in future monitoring of the environmental quality of the park. Primary objectives of the Draft Management Plan (YBPT, 1990), to "conserve, rehabilitate and enhance the natural vegetation and wildlife habitat ... conduct programs to combat the threats from erosion and from weed and vermin invasion", to "encourage scientific research and ongoing monitoring of management programs," and to "increase understanding of the conservation and management needs for flora and fauna", are to be applauded, but ongoing work should take into account the needs of butterflies and other insects. Large scale planting of indigenous species will undoubtedly be beneficial for the insect fauna. A native grassland strategy could specifically benefit the Xenicas and other Browns and the Skippers. The zeal to eradicate exotic vegetation should not extend to the few isolated specimens of trees and shrubs which are important nectar sources and

gathering points for insects until suitable replacements are available. The possibility of reintroduction of butterfly species may be a consideration in the future, after a more thorough survey of the current populations is completed.

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Library News

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Boland, D.J. (1984). 'Forest trees of Australia'. 4th ed. (A.G.P.S.: Canberra.)

Common, I.B.F. (1990). 'Moths of Australia'. (M.U.P.)

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Books are available for loan for two months, and may be renewed for a further period if required.

The library also stocks a large collection of periodicals, see list in *The Victorian Naturalist* 109 no. 3 June 1992.

The library will be open from 11 a.m. - 2 p.m. on Wednesdays only from 1st December, and will be closed during January. It is open before General meetings from 7.15 p.m.

A Preliminary Report on the Status of Sugar Gliders *Petaurus breviceps* (Waterhouse) Reintroduced into Blackburn Lake Sanctuary, Victoria.

Kris Juzva and Paula J. Peeters*

Abstract

In 1984-5, as part of a re-introduction programme, 43 Sugar Gliders *Petaurus breviceps* were released into Blackburn Lake Sanctuary, a suburban forest remnant in Melbourne, Victoria. Prior to this study the success of the re-introduction was uncertain. The status of the Sugar Glider in Blackburn Lake Sanctuary was examined during 1990 by trapping, spotlighting, hair-sampling and the examination of nestboxes over a six month period. Sugar Gliders were not detected in the Sanctuary. The integrity of the various survey methods used is questionable. Possible reasons for the apparent failure of the re-introduction are considered. The failure has implications for the survival of natural populations in similar areas, and for the outcome of similar reintroductions.

Introduction

In 1984-5, 43 captive-bred Sugar Gliders *Petaurus breviceps* were released into Blackburn Lake Sanctuary, a suburban forest isolate (D. Hackett, personal communication). This programme aimed to re-establish a population of Sugar Gliders in the sanctuary after the original naturally occurring population reportedly died out in the early 1970's (J. Wallbrink, *Eastern Standard*, May 15, 1984). Because nesting hollows were thought to be scarce, 32 nestboxes were placed throughout the sanctuary. Two fatalities have been recorded since the re-introduction (J. Wallbrink, unpublished note).

In April 1988, the Department of Conservation, Forests and Lands concluded that the gliders were not thriving within the sanctuary, as only one animal was captured during a follow-up study (letter to D. Hackett from the Department

of Conservation, Forests and Lands). The methodology employed, which consisted only of trapping and checking nestboxes, along with reports of sightings by local residents during late 1988-90 (B. Hansen, Blackburn Lake Sanctuary committee of management, pers. comm.) prompted us to consider that the C.F.L. survey may have failed to detect a surviving population of Sugar Gliders within the sanctuary.

Re-introduction programmes involving this species are not new. Suckling and Macfarlane (1983) and Suckling and Goldstraw (1989) document a successful Sugar Glider re-introduction in 1979-81 at Tower Hill, Victoria. As the population had not only persisted for eight years, but was also bigger in 1986 than in 1981, it was concluded that the reintroduction had been a success (Suckling and Goldstraw 1989). Given the success of this re-introduction programme, the population status of the Sugar Glider in Blackburn Lake Sanctuary is of considerable interest.

Materials and Methods

The status of the Sugar Glider in Blackburn Lake Sanctuary was examined during the winter and spring of 1990.

Study site

Blackburn Lake Sanctuary is a 25 ha reserve located in Blackburn, Victoria (37°40'S, 145°0'E). Primarily used for recreation, the reserve is located within a suburban area surrounded on all sides by large main roads. Several smaller isolates of re-planted and remnant forest occur outside the Sanctuary boundaries, but within the region delimited by main roads.

The vegetation of the Sanctuary consists of a sparse overstorey of eucalypts and wattles. These include *Eucalyptus viminalis* (Manna Gum), *E. radiata* (Narrow-leaved

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Peppermint), *Eovata* (Swamp Gum), *Egonioalyx* (Long-leaved Box), *Eobliqua* (Messmate), *Acacia mearnsii* (Late Black Wattle), *A.pycnantha* (Golden Wattle), *A.dealbata* (Silver Wattle), *A.baileyana* (Cootamundra Wattle), *A.longifolia* (Sallow Wattle) and *A.melanoxylon* (Blackwood). The understorey is dense and relatively tall (2-4 metres). Dominant species include *Bursaria spinosa* (Prickly Bursaria), *Hakea sericea* (Bushy Needlewood), *Leptospermum* (Tea-tree) sp. and *Melaleuca* (Paperbark) sp.

Nestboxes

Thirty-two nestboxes were located within the reserve. Nestboxes were subsequently examined in July 1990 for the presence of Sugar Gliders or signs of their occupancy. Sugar Gliders weave green eucalypt leaves into a hollow ball up to 25 cm in diameter and cover the entrance with leaves in cold weather (Triggs 1984, p. 59). Owing to the absence of a removable lid, each box was inspected through the front entrance hole using a torch and a dental mirror attached to a 300mm long adjustable handle. The use of a stick to move nesting material and manipulation of the dental mirror enabled a thorough examination of the nestboxes. Eight of the boxes could not be reached, while four boxes were occupied by bees.

Hair Sampling and Analysis

Double-sided adhesive tape ('Supertape', No. 605, supplied by John Danks and Son, Pty. Ltd., Braeside, Melbourne) was placed around the entrance hole of all accessible nestboxes to obtain hair samples of the animals using them.

Hair samples were also collected in August/September 1990 using baited plastic tubes (10 cm x 3 cm) lined with double-sided adhesive tape (Suckling 1978). Bait consisted of peanut butter, honey and rolled oats. Sixty tubes were distributed randomly throughout the Sanctuary. Tubes were attached to a variety of *Eucalyptus* and *Acacia* trees at heights ranging 2-4m above the ground. All tubes were removed after 6 days.

Hairs obtained from the nestboxes and hairsampling tubes were mounted whole in water, and observed under x100 magnification using a compound microscope. Initially, transverse sections were prepared by hand following the method of Brunner and Coman (1974). However, most hairs were lost using this method, so the remaining hairs were embedded in resin and sectioned using a microtome. Hairs were identified using Brunner and Coman (1974).

Spotlighting

A total of nine hours spotlighting by two experienced observers was carried out on foot using two 30 watt spotlights. The spotlighting route was confined to the pathways extending throughout the Sanctuary. The entire reserve was surveyed at least once using this technique.

Trapping

Aluminium Elliot traps, 30cm x 10cm x 10cm (Elliot Scientific Co., Upwey, Melbourne) were set 2-3m above the ground in a variety of *Eucalyptus* and *Acacia* trees. Traps were either tied to horizontal branches or attached to trunks using wooden trap stands.

The traps were wrapped in plastic bags and baited with a mixture of honey, peanut butter and rolled oats. A dilute mixture of honey and water was sprayed over the traps and on surrounding branches. Thirty traps were set throughout the reserve during September 1990. A total of 140 trap nights were spread over 5 consecutive nights.

Newspaper article

An article describing the background and aims of the survey was published in the *Nunawading Gazette*, 5th September, 1990. This included a description of the Sugar Glider and a request for any information on Sugar Gliders in the area to be forwarded to the authors.

Results

Sugar Gliders were not detected in Blackburn Lake Sanctuary during this survey.

All nestboxes were found to contain a mixture of leaves, small branches, plastic bags and feathers. No small animals were found within the nestboxes with the exception of a Ringtail Possum *Pseudochierus peregrinus*, in one of the nestboxes.

Analysis of the adhesive tape placed around the entrance holes of the nest boxes revealed only fibres from feathers. The hair sampling tubes yielded hair samples from the genus *Rattus*. In addition, one hair sample was identified as belonging to a possum or glider, however, further identification to species level was not possible.

During nine hours of spotlighting, Common Brushtail Possums *Trichosurus vulpecula*, Ringtail Possums *P. peregrinus* and a rat *Rattus* sp. were the only arboreal mammals observed.

Two Indian Mynas *Acridotheres tristis* were the only animals trapped, although several traps were sprung without captures.

Public response to the newspaper article revealed only one likely sighting of a Sugar Glider, near the corner of Blackburn Road and Bindy Street (1.2km south of the sanctuary) in mid-1989.

Discussion

Previous surveys of Sugar Gliders in Blackburn Lake Sanctuary have only used two methods. In this study, four methods were used, yet Sugar Gliders remain undetected in the reserve. However, it cannot unequivocally be concluded that the Sugar Gliders released into the reserve in 1984-85 have died out. Instead, the results must be evaluated in context of the methods employed and their effectiveness. The value of the various methods used will be discussed.

Spotlighting

Spotlighting is an accepted technique used by naturalists and researchers to detect the presence of Sugar Gliders (Davey 1990). Thus, the lack of positive sightings of *P. breviceps* would seem to add support to the conclusion that Sugar Gliders are not present in the reserve, or are present

in numbers too low to allow detection using this technique.

Hair sampling

Evaluation of this technique by Suckling (1978) showed that, although this method is successful in detecting the presence of Sugar Gliders, it is only "about as successful as spotlighting for the detection of *P. breviceps*" (p. 249). Thus, the effectiveness of this method as a surveying tool may be limited. Furthermore, it was observed in this study that the adhesive properties of the tape were significantly reduced after a period of six days, particularly if it had been raining during this time. Thus, modifications of the tube design, similar to that suggested by Scotts and Craig (1986) may be desirable in future studies.

Trapping

In an extensive study concerned with assessing the effectiveness of trapping as a method for detecting Sugar Gliders, Smith and Phillips (1984) showed that trapping success is highly seasonally dependant. This was attributed to changes in the number of animals known to be alive throughout different seasons. Thus the lack of success in detecting Sugar Gliders in the sanctuary using trapping may not be indicative of the population status of the Sugar Glider in the reserve. This might be particularly true for low density populations of Sugar Gliders. Nonetheless, we consider that the more intensive trapping effort of this study made it a more thorough and hence more conclusive survey than that carried out in 1988 by the Department of Conservation, Forests and Lands. Interestingly, B. Traill (pers. comm.) notes that trapping success of Sugar Gliders is generally higher in times of low food availability.

Given that there was no winter flowering during the period of trapping in this study (pers. obs.), the lack of captures of *P. breviceps* is indicative of an absence or very low population level of *P. breviceps* in Blackburn Lake Sanctuary.

Possible factors affecting the suitability of Blackburn Lake Sanctuary to support a population of Sugar Gliders

The absence of Sugar Gliders from nestboxes within the sanctuary, while indicating a lack of gliders, may also suggest the gliders either prefer natural hollows for nest sites, or are being excluded by larger animals. Nestboxes of the same design are used by Sugar Gliders at Tower Hill State Game Reserve (Vic.) (Suckling and MacFarlane 1983). However, the absence of natural hollows at this site may preclude any preference gliders may show when alternate nest sites are available. In addition, the dimensions of the nestboxes installed in the sanctuary may permit the access of larger competitors, resulting in the exclusion of Sugar Gliders. The observation of a Common Ringtail Possum within a nest box demonstrated that the entrance hole of the boxes were sufficiently large to allow colonization by arboreal mammals larger than Sugar Gliders. Indeed, Menkhurst (1984) has noted a preference by Sugar Gliders for nest boxes with entrance holes which provide a tight fit, presumably to exclude larger species. Thus the absence of Sugar Gliders from nestboxes could be attributed to a number of factors.

Smith and Lindenmayer (1988) demonstrated the dependence of possums and gliders on the availability of potential nesting trees (PNT's). They further showed that for Leadbeater's Possum *Gymnobelideus leadbeateri*, a minimum density of PNT's may be reached (4.2 PNT's per 3 ha.) below which Leadbeater's Possum does not exist in the forest. Due to limited time, the density of PNT's suitable for Sugar Gliders in Blackburn Lake Sanctuary was not examined.

The diet of the Sugar Glider includes nectar, gum and sap as well as insects (Smith 1982). Food resources available to Sugar Gliders within the reserve were qualitatively assessed. Dominant tree species include Swamp Gum *Eucalyptus ovata*, Manna Gum *E. viminalis* and Narrow-leaved Peppermint *E. radiata*, associated with Black wattle *Acacia*

mearnsii and Silver wattle *A. dealbata*, all of which are known to be used as food trees by Sugar Gliders (Smith 1980, Kavanagh 1984). Thus it would appear that food is not a limiting resource for the Sugar Glider in Blackburn Lake Sanctuary.

Perhaps the most important factor accounting for the demise of the reintroduced Sugar Gliders is predation by native and feral animals (Suckling 1984). Feral and domestic cats, foxes and dogs have been seen within the reserve (B. Hansen, pers. comm., and personal observation) and may constitute a considerable barrier to the successful reintroduction of Sugar Gliders within Blackburn Lake Sanctuary (Brunner *et al.* 1975, Brunner *et al.* 1991).

The absence of Sugar Gliders in Blackburn Lake Sanctuary may be due to dispersal of the released animals rather than factors leading to mortality. However, the sanctuary is located in a region surrounded on all sides by large main roads which may provide a considerable barrier to the dispersal of this species out of the immediate area. Nonetheless, it is possible that the animals released into the sanctuary have dispersed to other forested isolates within the area delineated by these roads. Further work is needed to investigate this hypothesis.

Conclusions

The apparent failure of the reintroduction of Sugar Gliders into Blackburn Lake Sanctuary has important implications for the success of future reintroduction programmes for native fauna, particularly in suburban areas, and also for the survival of natural populations in forest remnants. Suckling (1980) has suggested that the minimum viable size of a reserve for the conservation of Sugar Gliders and associated mammals is 2000ha. This conclusion was reached after studying a collection of fragmented habitats which were characterized by abundant food resources. Blackburn Lake Sanctuary covers a considerably smaller area. Given the extensive residential development surrounding the sanctuary, the pressure of

predation by domestic and feral animals is probably higher. Thus the absence of Sugar Gliders from Blackburn Lake Sanctuary may not be very surprising, although the results of the study must be interpreted with caution.

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Sub-Fossil Potoroos in South-Eastern Australia; with a Record of *Potorous longipes* from New South Wales

J.H. Seebeck*

The small marsupials of the family Potoroidae comprise a group which has been dramatically reduced in range and abundance as a result of post-European settlement changes to the environment (Seebeck and Rose 1988). The presence of remains, as sub-fossil, in cave deposits has therefore been used to aid the determination of the extent of the former distribution of a number of species. Several authors (Hope 1969; Johnston 1973; Seebeck 1981; Seebeck, Bennett and Scotts 1989) have incorporated such data in reporting upon *Potorous tridactylus*, which species is present in many deposits in Victoria (Wakefield 1969).

In 1980 Seebeck and Johnston described a new species, *Potorous longipes* from modern material collected in east Gippsland, Victoria. *P. longipes* has not been reported from any sub-fossil sites in eastern Victoria or south-eastern New South Wales (from whence Dovey (1987) has described its recent discovery as a living species). However, Hope (1969) recognised the novelty of a specimen of *Potorous* from Yarrangobilly Caves, New South Wales (Fig.1) in relation to other specimens of

Potorous she had examined. She segregated that specimen and two other enigmatic specimens (C 6761 and C 6973 in the collections of Museum of Victoria) which had been collected in Victoria in the 19th century, from *P. tridactylus* and *P. apicalis*. These names are now synonymized in *P. tridactylus* (Johnston 1973; Johnston and Sharman 1976). The odd specimens are presently under study; they are not *P. tridactylus* and may represent an undescribed taxon. Seebeck (1981) excluded them from his discussions of *P. tridactylus* in Victoria.

I have re-examined the Yarrangobilly specimen (N.A. Wakefield Y1 in Hope 1969; now F 81966, in the collections of The Australian Museum (AM), Sydney). It was probably collected by the late J.A. Mahony, then at the Department of Geology and Geophysics, University of Sydney. However, details of collection date and precise location in the caves complex cannot now be ascertained (J.H. Hope, Australian National University, *in litt.* 8 August 1980).

The specimen (shown in Fig.2) consists of a damaged skull and associated left dentary. The dorsal surface of the skull has been eroded; the nasals, frontals and parietals are missing. Almost the entire ventral area is complete; it lacks only the hamular processes, which have been broken off. The only teeth missing are the right I2 and I3 and the left I3. M5 is barely erupted. In life the tooth may not have broken through the gum tissue. Wear on all other teeth is minimal. I consider the animal to be young, just adult, on the basis of the eruption of the permanent premolar, the condition of M5 and the lack of significant tooth wear. In *P. tridactylus* that combination of characters is found in animals less than 18 months old (Seebeck, unpublished). *P. longipes* attains adult size at about 15 months (Seebeck 1992). The coronoid process of the dentary is broken

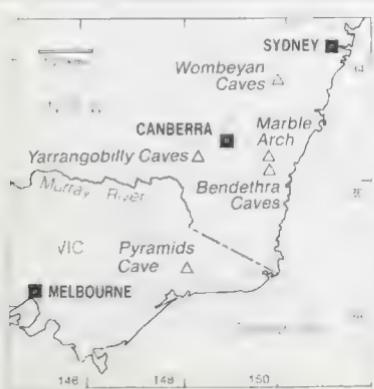


Fig. 1. Localities mentioned in the text.

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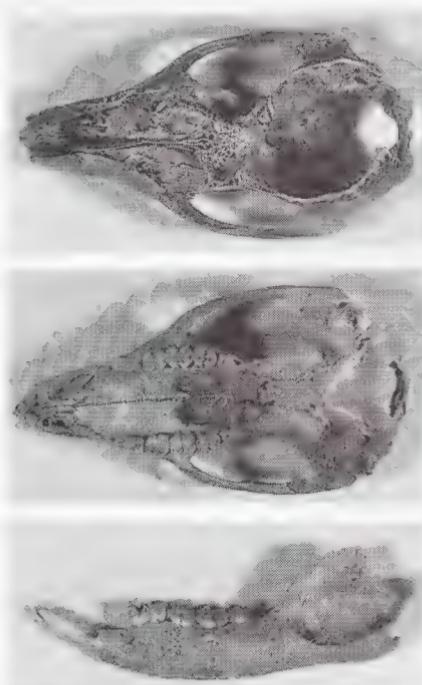


Fig. 2. *porous longipes* from Yarrangobilly. Skull (dorsal and ventral views) and left dentary.

off about half-way along the ascending ramus, otherwise the dentary is complete. All teeth except M5 are present. The latter had erupted, or nearly so, judging from the appearance of the alveolus.

I identify specimen AM F 81966 as *P. longipes* for the following reasons, when compared with *P. tridactylus*: the jugal-squamosal junction is anterior in position relative to the premaxilla; the paroccipital process is enlarged; the tympanic bullae are narrow; the gap between I3 (alveolus) and C is small; M5 is small; a large foramen anterior to the optic foramen is present. It cannot readily be photographed but is not present in *P. tridactylus*; the palatal foramina are large. The dentary is robust with a more acutely-angled ascending ramus. Table 1 provides measurements of the specimen and measurements from the series of adult or near-adult *P. longipes* presently available, for comparison. Both skull and dentary are marginally shorter than the shortest skull measured (a sub-

adult, NPWD 13346) but all other measurements fall within the range determined for *P. longipes* and exceed similar values for *P. tridactylus* from east Gippsland (Seebeck and Johnston 1980).

Table 1: Measurements (mm) and cranial and mandibular ratios of Yarrangobilly *P. longipes* compared with modern specimens (* n=6. All others n=7).

Abbreviations:

BAL	- basal length of skull;
ZW	- maximum width across the zygoma;
PR-S/J	- distance between most anterior point of premaxilla and most anterior part of the jugal/squamosal suture;
PAW	- maximum width of palate from external border of molar alveolae;
PAL	- maximum length of palate from posterior border to most anterior part of premaxilla;
PFL	- length of palatine foramina;
TBL	- length of tympanic bulla;
LP'	- length of permanent premolar;
LM ²⁻⁴	- length of molar row at alveolae;
LD	- maximum length of dentary;
WR	- maximum width of ramus;
HDM ₁	- height of dentary at M ₁ ;
WDM ₁	- width of dentary at M ₁ ;
AR	- angle of ascending ramus.

	Yarrangobilly	Modern	
		Mean \pm SD	Range
BAL	73.5	77.61 \pm 2.16	74.2 - 80.3
ZW	41.2	44.40 \pm 2.24*	41.0 - 46.7
PR-S/J	52.4	55.87 \pm 1.49*	53.5 - 57.6
PAW	21.2	21.39 \pm 0.70	20.5 - 22.5
PAL	46.2	47.77 \pm 3.16*	43.6 - 51.5
PFL	12.5	12.76 \pm 0.70*	11.7 - 13.6
TBL	8.5	8.39 \pm 0.34	7.7 - 8.7
LP'	7.0	6.55 \pm 0.37*	6.0 - 7.0
LM ²⁻⁴	15.0	13.81 \pm 0.73	13.0 - 15.3
LD	49.6	54.94 \pm 2.57	50.6 - 58.5
WR	16.8	16.12 \pm 1.03	14.5 - 17.2
HDM ₁	9.0	8.93 \pm 0.45	8.3 - 9.5
WDM ₁	4.7	5.20 \pm 0.57	4.6 - 6.2
AR	126°	126.70° \pm 4.07°	122° - 132°
M ¹ LxW	3.1x3.1	3.33 \pm 0.22*	3.1 - 3.7
		x3.32 \pm 0.32*	x3.0 - 3.9
PR-S/J/BAL	0.713	0.719 \pm 0.004*	0.713 - 0.726
ZW/BAL	0.561	0.570 \pm 0.018*	0.55 - 0.60
PFL/PAL	0.271	0.267 \pm 0.020*	0.23 - 0.28
LP'/BAL	0.095	0.084 \pm 0.004*	0.078 - 0.087
LM ²⁻⁴ /PA	0.204	0.293 \pm 0.015*	0.27 - 0.31
HDM ₁ /LD	0.181	0.166 \pm 0.008*	0.16 - 0.18
WR/LD	0.339	0.293 \pm 0.020*	0.26 - 0.32

Both skull and dentary were visually compared with the type specimen of *P. longipes* (and all other specimens of that species that are available) as well as representative examples of *P. tridactylus* from east Gippsland.

Other specimens of *Potorous* have been collected at Yarrangobilly Caves, some by J.A. Mahony (details unknown) and some by J.H. Hope in December 1970, from North Deep Creek Cave. The material, which is in the Australian Museum, consists of two damaged skulls, AM F 81969 and F 82134, and four dentaries, F 81967, F 81968, F 82135 and F 82136. One of the dentaries F 81967 or F 81968 may have been associated with skull F 81969 but this is uncertain.

All this material is identified as *P. tridactylus* by reference to known specimens and to the published description of *P. longipes* (Seebek and Johnston 1980). Dentaries of *P. tridactylus* are much less robust than those of *P. longipes*, and the ascending ramus angle is much greater. All the specimens are juvenile or sub-adult *i.e.* deciduous premolar P2 and deciduous molar M1 present, permanent molar row incompletely erupted.

Several other cave deposits in south-eastern Australia have yielded *Potorous*. Hall (1977 and *pers. comm.* 1979) found *P. tridactylus* at Marble Arch and Bendethra Caves, both south of Braidwood, New South Wales. All the specimens were isolated incomplete dentaries, two (M2/6 and M2/7) from Marble Arch, and two (CM 34.1 and CM 34.2) from Bendethra. All are juveniles, all with P2 and M1 (or their alveoli) present. In three of the specimens M3 is unerupted, in the other it has only just erupted. I have examined these specimens and confirmed Hall's specific identification.

Dovey (*pers. comm.* April 1988) collected a single maxillary fragment from Clarke's Cave, near Marble Arch. I have examined this specimen, which consists of the molar tooth row and associated bone. It is *Ptridactylus*, an adult with virtually unworn teeth.

Gorter (1977) reported a single specimen of *Ptridactylus* from Douglas Cave south-east of Dubbo. No details were given and I have not examined the specimen. The age of the deposit was estimated at about 29,000 years BP. The site is remote from any presently-known *Potorous* locality.

Broom (1896) described *P. tridactylus antiquus* from the Wombeyan Caves breccia; Ride (1969) retrieved further specimens of *Potorous* from the breccia, but did not revise the status of the form, believing that the fauna of the breccia was composed largely of extinct precursor forms of modern species. Wakefield (1969, 1972) re-examined Broom's and Ride's material and concluded that many of the novelties described by Broom were, in fact, conspecific with modern species, although slightly smaller in size. The nominated lectotype of *P. tantillus* (AM F 4201) is juvenile, with P3 unerupted. The paratype AM F 51880 is incomplete, with P3 not fully erupted. I have examined these two specimens and confirm that they are *P. tridactylus*.

Wakefield (1960, 1967) reported *P. tridactylus* from the Pyramids Cave in the Buchan area, Victoria. Adult and juvenile remains were included in the collection, but all are referable to *P. tridactylus*. Later, Wakefield (1969, 1972) recognized two forms of *Potorous* in eastern Australia, but confused their identities in attempting to assign them to then-existing named taxa. He separated *P. tridactylus* from *P. apicalis* on the basis of cranial proportions (broad palate and rostrum v. narrow palate and rostrum), curvature of the tooth row (curved v. straight) and shape of P3 (curved v. straight). He applied the name *P. tridactylus* to animals from south-western Western Australia, "eastern N.S.W.", the "mountains of eastern Victoria", the Wombeyan fossil material of Broom and Ride, and to the modern specimen registered FWD MT1878 (FWD = Fisheries and Wildlife Division, Victoria). This last specimen is in fact a paratype of *P. longipes* (Seebek and Johnston 1980). The name *P. apicalis* was applied to animals from Tasmania, Bass Strait islands

and southern Victoria, and to all the cave deposit specimens examined by Wakefield (1969). But *P. apicalis* = *P. tridactylus* (Johnston and Sharman 1976), and all material, both that from cave deposits and modern specimens reported by Wakefield is *P. tridactylus*, with the sole exception of MT1878 referred to above.

Wakefield (1963a, b, 1964a, 1967) reported the occurrence of *P. tridactylus* in a number of cave deposits in western Victoria. All the specimens that I have been able to examine from these collections are *P. tridactylus*. Wakefield (1964b) also identified *P. platyops* (as *P. morgani*, a junior synonym) from archaeological deposits on the lower Glenelg River, South Australia. That species is not recorded from Victoria.

Although few sub-fossil and fossil specimens of *Potorous* are thus far known from south-eastern New South Wales and eastern Victoria, the fact that only one has been referable to *P. longipes* supports modern observations that the species is, and probably always has been rare. It should be noted that Yarrangobilly is some 190 km north of the northern-most locality in Victoria, about 180 km north-north-west of the New South Wales site reported by Dovey (1987) and is now bioclimatically quite different from known and predicted *P. longipes* habitat (Scotts and Seebeck 1989; Norton and Saxon 1991); no palaeoecological conclusions can be drawn from this occurrence.

Acknowledgements

My thanks to Jeanette Hope, Liz Dovey and Les Hall for allowing me to examine specimens collected by them, and to Dr Alex Ritchie (The Australian Museum) for providing casts of Wombeyan Caves *Potorous* specimens. Joan Dixon, Museum of Victoria, provided ready access to *Potorous* material held in that Institution.

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The Broad-toothed Rat (*Mastacomys fuscus*) in Dandenong Ranges National Park — a Colony Located in Regenerating Forest

Robert L. Wallis*

The Broad-toothed Rat (*Mastacomys fuscus*) is a native rodent with a disjunct distribution in south-eastern Australia (Watts and Aslin 1980). The species has been classified as rare in Victoria (Baker-Gabb 1990). A small colony was located in Sherbrooke Forest in 1970 and the species' presence in Sherbrooke has been monitored since using predator scat analysis (Wallis *et al.* 1982). *M. fuscus* has been detected in fox scats collected between 1973 and 1985 with frequencies of occurrence ranging from 4% to 1% of scats (Wallis and Brunner 1987).

A technique to locate *M. fuscus* has been developed which does not rely on trapping (Wallis 1988). The technique involves searching in suitable grassy sites (often along tracks) and in dense wire grass under *Eucalyptus regnans* for runways with the obvious green scats of *M. fuscus*. The scats of the other native rodent which is common in the Park, *Rattus fuscipes*, appear often in the same runways, but are somewhat narrower, longer and much darker in colour. Microscopic analysis of grooming hairs in the *M. fuscus* scats is used to confirm the presence of *M. fuscus*. In contrast, the location by trapping may require a series of special techniques involving pre-feeding with appropriate bait and the removal of other small mammals from the trap site, as described in Brunner *et al.* 1977.

Recently a colony of *M. fuscus* was found in the Sherbrooke Forest region of Dandenong Ranges National Park. The colony lives in an area which was formerly an old pine plantation (*Pinus radiata*). It was clearfelled in stages between late 1985 and early 1987. The site is at the south-western edge of the old plantation and was the last section to be cleared. Regrowth in

the area is now four years old, and contains *E. regnans* (up to 3 m high) and a dense shrub layer of *Cassinia aculeata*, *Acacia dealbata*, *Coprosma quadrifida*, *Bedfordia arborea*, *Pimelea axifolia* and other species typical of the tall open forest in Sherbrooke, as well as a ground cover of Wire Grass (*Tetrarrhena juncea*) and other grasses and mosses. The site was found to contain many runways with large quantities of the green scats considered characteristic of *M. fuscus* (Wallis 1988).

To confirm the presence of *M. fuscus* wire cage traps (33 x 20 x 16 cm) covered with plastic for protection and baited with peanut butter, honey and rolled oatmeal were set over four consecutive nights. One *M. fuscus* was trapped on night three. Its identification was confirmed by the presence of some green scats in the cage trap, and a tuft of hair was removed from the specimen's back and microscopically examined back in the laboratory. The scales at the base of the larger guard hairs had typically pointed ends — a feature which distinguishes *M. fuscus* from *R. fuscipes* (Brunner and Coman 1974). From the 78 traps set in total, 11 *Antechinus stuartii*, five *R. fuscipes* and one *M. fuscus* were captured. The Broad-toothed Rat is considered a very difficult mammal to trap when it exists in low densities (Wallis *et al.* 1982); interestingly, it was not necessary in this case to use pre-feeding or remove other species in order to trap *M. fuscus*.

There is some evidence that foxes and cats prey selectively on *M. fuscus* in preference to other rodents such as *R. fuscipes* (Green and Osborne 1981; Brunner pers. comm.). Thus the current fox control program within the Park and attempts at cat confinement by Sherbrooke Shire Council could well be important factors in the future survival of the *M. fuscus* colony.

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The next stage in this project is to search for other colonies of *M. fuscus* in the Dandenong Ranges National Park. Whilst the species is likely to occur in very low densities in the mature forest where dense wire grass and thick understorey exists under a *E. regnans* upper canopy (Wallis *et al.* 1982), it is possible that colonies of higher densities might live in more open sites with soft grasses, such as the site described in this paper.

I would like to thank Hans Brunner whose great knowledge and experience led to his identifying the site initially, and Linda Moon, Simone Louwhoff and Sarah Meachem for help with the trapping. Trapping was carried out under National Parks and Wildlife Permits 90-080 and 901/002 and with the approval of the Victoria College Animal Experimentation Ethics Committee. John Lloyd is particularly thanked for his support throughout this study and in our many years of research at Sherbrooke previously. The two anonymous referees are also thanked for their helpful suggestions about the manuscript.

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Monkey Vine or Gargaloo - *Parsonisia eucalyptophylla* F. Muell. A New Species for Victoria

James R. Turner and Lyn Turner*

Whilst holidaying on the Snowy River near Wallis on the Victorian/New South Wales border a field botany trip was undertaken. The area visited was situated within the Cobberas/Tingaringy National Park south of Sandy Creek, 6 kilometres from Wallis. Some 100 metres up on the rocky slope from the Snowy River a creeper was noted. This was a species I had not encountered before.

Specimens were collected and forwarded to Mr. D. Albrecht of the Melbourne Herbarium. These specimens were identified as *Parsonisia eucalyptophylla*, a new taxa for Victoria.

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Parsonisia eucalyptophylla occurs in the western plains, western slopes and far western plains botanical divisions of New South Wales where it is found in sandy to loamy, or, red sandy soils. These shallow soils support Cypress Pine, Box and Mallee woodlands (Cunningham *et al.* 1981).

The habitat of the Victorian population occurs in shallow sandy rocky soil within the rain shadow area of the upper Victorian reaches of the Snowy River. Cypress Pine (*Callitris glaucophylla* and *C. endlicheri*) and White Box (*Eucalyptus albens*) woodland.

On a subsequent visit to this site a more comprehensive examination of the area was undertaken. Approximately 27 mature

plants also with 50 more seedlings were noted. Of the mature plants 10 were growing over rocks whilst the remaining plants were on nearby trees. These specimens ranged in height from 2 to 12 metres. The largest specimen had climbed to the top of the Black Cypress Pine (*C. endlicheri*) and now reached beyond the top of this tree. The common name of Monkey Vine or Gargaloo appears to be an apt one.

Parsonia eucalyptophylla has linear to lanceolate (8 x 0.5 - 2 cm) leaf-blades in mature plants. Leaves are dull green above and paler below. Leaf minutely pubescent below and sometimes above, gradually attenuate at the apex and more abruptly so at the base, mostly pendulous. Foliage dimorphic, the juvenile plants with small ovate, cordate leaves 2-5 cm long (Beadle 1984) (see also Fig. 1). Flowers yellow, pedicellate, in many flowered terminal and axillary panicles. Corolla lobes linear, strongly revolute. Anther cone long and exerted above the corolla on spirally twisted filaments. Tall woody climber.

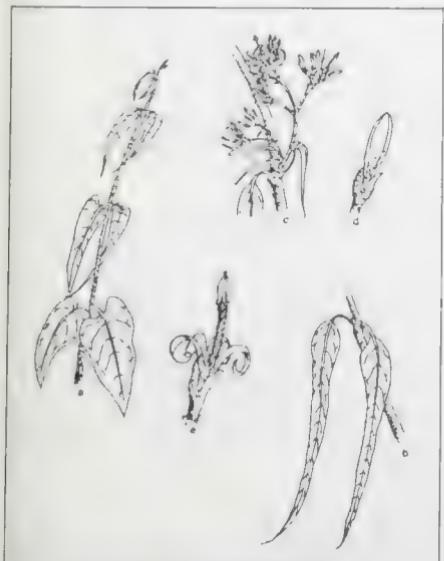


Fig. 1. (a) Juvenile leaves x 1. (b) Adult leaves x 0.5. (c) Flowers and Buds x 1. (d) Enlargement of Bud near opening stage x 8. (e) Enlargement of flower x 8 (front petal omitted). Illustrations by Lyn Turner.

As the population is small, *P. eucalyptophylla* (Gullen *et al.* 1991) is considered to be a vulnerable species in Victoria. At present the population appears relatively secure as it occurs in a rather remote area of the National Park.

Victoria has one other species of *Parsonia*, *P. brownii* (Britten) Pichon, the Twining Silk-pod. Although bearing a somewhat superficial resemblance to *P. eucalyptophylla*, *P. brownii* has shining dark green, lance-shaped leaves to 10 cm long, much paler beneath. Smaller dull yellowish green flowers with corolla lobes not strongly revolute. Anther cone not long and exerted above the corolla. *P. brownii* occurs in many places across southern Victoria and favours the cool moist forests, usually in rainforest or fern gullies.

In this botanically interesting area of the Snowy River occurs several other species of note. These species are otherwise only known from the drier northern area of the State or from the Mallee.

Included are:

Helichrysum adnatum - This shrubby *Helichrysum* is known from only two other localities in Victoria, viz, the nearby Suggan Buggan area and near Bindi in the upper Tambo River valley.

Acacia doratoxylon - In Victoria previously only known from a few localities. Near Beechworth, Gattamurh Creek and McKillops Bridge. At this site a nearby hill is abundant in this species.

Phebalium glandulosum - A species considered rare in Victoria, where it was only known from a few sites in the Mallee and the Snowy River Gorge.

Cassia nemophila - Although common in the northwest of the State, this species in eastern Victoria is confined to this area where it is localised. In terms of biogeographical occurrences it is an interesting disjunct occurrence.

Bertia cunninghamii - Considered rare in Victoria where it is confined to the upper Snowy River and the Wellington River.

Corybas hispidus - A rare orchid species inhabiting moist shady habitat. Located here on a moist shady slope.

Since the discovery of *Parsonisia eucalyptophylla* in 1989 further field trips to this area have uncovered several other new State records.

These are:

Acacia binervia (Wendl.) Macbride.

Abutilon oxycarpum var.

subsagittatum Domin.

Cyperus fulvus R. Br.

Cyperus gracilis R. Br.

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The M.A. Ingram Trust for over forty five years has been making grants for the preservation and study of the mammals and birds of Australia. Its founders, John and Will Ingram, were active members of the FNCV in the early part of this century. The Managing Trustees today are —

a nominee of the FNCV (as present Dr J.H. Willis)

a nominee of the RAOU (as present Mr Sid Cowling)

the professor of zoology at Melbourne University (at present Professor Graeme Campbell)

and Eric Allen.

Since August 1986, over 103 grants have been made to applicants for projects. Some examples are —

to the FNCV Fauna Survey Group for equipment required for the study of the Water Rat at the MMBW Farm at Werribee

to the Healesville Sanctuary Zoological Board of Victoria towards the cost of construction of pens, nests, etc for the Breeding of Leadbeater's Possum at Healesville Sanctuary for eventual release into suitable areas of bushland.

to the Victorian Conservation Trust to assist in the purchase of land adjoining Nepean State Park, Green's Bush on Mornington Peninsula.

to Andrew Burton of the James Cook University for the study of the black, grey and peregrine falcons in the Australian arid zones.

It is a perpetual Trust and over the years, because of inflation, the real value of the money available has diminished while the number of applicants worthy of assistance has increased. Any member of the FNCV desiring to contribute to the ongoing preservation and research of Australian wildlife could consider making a bequest to the M.A. Ingram Trust. More information can be obtained from either Dr. James H. Willis (592 7701) or Eric Allen (885 4559), both members of the FNCV.

Some Impacts on Arboreal Marsupials of Clearfelling on a 80-120 year Rotation in Mountain Ash (*Eucalyptus regnans*) Forests in the Central Highlands of Victoria

D.B. Lindenmayer*

Introduction

The Mountain Ash, *Eucalyptus regnans* F.Muell. forests of the Central Highlands of Victoria contain some of world's tallest flowering plants and provide habitat for a wide range of wildlife including the endangered species Leadbeater's Possum, *Gymnobelideus leadbeateri* McCoy.

These forests also support some of the most valuable timber and pulpwood resources in eastern Australia and large areas of Mountain Ash forest are presently designated for wood production (Macfarlane and Seebeck 1991). The predominant type of silviculture employed in these forests is clearfelling (Department of Conservation and Environment 1990). This involves the removal of most or all stems in one operation. High intensity fires are used to burn the slash and debris remaining after timber harvesting and promote the regeneration of logged sites. The presently proposed rotation time for such practices in Mountain Ash forest is 80-120 years (Department of Conservation and Environment 1990) although substantial areas of 50 year forest are presently being logged.

This paper briefly summarises some of the impacts on arboreal marsupials of clearfelling on an 80-120 year rotation in Mountain Ash forests within the Central Highlands of Victoria. A more detailed treatment of the topics reviewed here is presented in papers published elsewhere (Smith and Lindenmayer 1988, 1992; Lindenmayer 1992; Lindenmayer *et al.* 1990a, b, 1991a, *et seq.*).

Datasets used in studies of arboreal marsupials in Mountain Ash forests

Much of the information outlined below is underpinned by the results of extensive

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surveys of the montane ash forests of the Central Highlands of Victoria. These surveys enabled the development of a large database which contained information on: (i) the presence and abundance of Leadbeater's Possum and other species of arboreal marsupials, (ii) environmental parameters (slope, aspect, topographic position, etc.), (iii) vegetation structure and plant species composition, and, (iv) the number, characteristics and the rate of decay and collapse of trees with hollows which provide nest sites for arboreal marsupials. In these studies a tree with hollows was defined as any living or dead stem that was 0.5 m in diameter, 6 m or more in height and contained obvious hollows (Lindenmayer *et al.* 1991b).

The data collected in these surveys was used to build statistical models of: (i) the nest tree and habitat requirements of various species of arboreal marsupials, (ii) the factors influencing the distribution, abundance and rate of collapse of trees with hollows, (iii) trends in the abundance of hollow-dependent fauna as a result of a predicted decline in the number of trees with hollows. The results of these analyses have been used to predict the likely impacts of timber harvesting operations on arboreal marsupials (Lindenmayer 1989; Lindenmayer *et al.* 1990a).

Species of arboreal marsupials inhabiting Mountain Ash forests

Mountain Ash forests in the Central Highlands of Victoria support a range of species of arboreal marsupials. These include: Leadbeater's Possum, *Gymnobelidues leadbeateri*; Sugar Glider, *Petaurus breviceps*; Yellow-bellied Glider, *Petaurus australis*; Mountain Brushtail Possum, *Trichosurus caninus*; Feathertail Glider, *Acrobates pygmaeus*; Common Ringtail Possum, *Pseudocheirus peregrinus* and Greater Glider, *Petaurodes volans*.

Trees with hollows and the nesting requirements of arboreal marsupials

Virtually all species of arboreal marsupials in Mountain Ash forests use large trees with hollows as den and nest sites (Lindenmayer *et al.* 1991b). The presence and abundance of almost all species is significantly influenced by the number of trees with hollows on sites and the availability of nest sites appears to be a factor limiting populations of arboreal marsupials in many areas of Mountain Ash forest (Smith and Lindenmayer 1988, 1992; Lindenmayer *et al.* 1990c, 1991a). Clearfelling operations on a 80-120 year rotation lead to a significant reduction in the number of trees with hollows (Lindenmayer *et al.* 1991c, 1991d). As a result typically there will be too few hollow-bearing trees on logged sites to meet the den and nest tree requirements of most species of arboreal marsupials (Lindenmayer *et al.* 1990a, 1991a).

Mountain Ash trees usually do not develop cavities that are suitable for occupation by arboreal marsupials until at least 120 years (Ambrose 1982). Trees occupied by Leadbeater's Possum and several other species are typically much older than this and may be 400 or more years old (Lindenmayer *et al.* 1991c). Thus, clearfelling operations where all or nearly all stems on a given site are removed every 80-120 years will prevent the development of suitable nest trees for most species of arboreal marsupials (Lindenmayer *et al.* 1991c).

Mountain Ash forests support a range of forms and types of trees with hollows (Lindenmayer *et al.* 1991b). These forms reflect trees in different stages of senescence and decay (Lindenmayer *et al.* 1990b). Various species of arboreal marsupials display a preference for trees with hollows with different measured characteristics (Lindenmayer *et al.* 1991b). For example, Leadbeater's Possum most often uses short, large diameter trees that are in a late stage of senescence. The Greater Glider is more commonly observed emerging from tall, large diameter trees with hollows (Lindenmayer *et al.* 1991b).

Forests most likely to contain the diversity of species of arboreal marsupials will be those that support a range of types of trees with hollows (Lindenmayer *et al.* 1990a, 1991c). Sites that have been clearfelled and regenerated with high intensity fires generally do not support such a range of types of trees (Lindenmayer *et al.* 1991d).

Old growth stands and arboreal marsupials

Several species of arboreal marsupials are more likely to occur, and are most abundant in old growth stands of Mountain Ash. The Greater Glider and Yellow-bellied Glider are more likely to be present in forests that are 90 or more years of age (Lindenmayer *et al.* 1990c, in review; Milledge *et al.* 1991). In addition, the abundance of arboreal marsupials *per se* appears to be greatest in mixed-aged stands where there is at least one old growth age class on site (Lindenmayer *et al.* in review). Given this, on those sites where clearfelling operations result in predominantly even-aged stands of regrowth forest that never attain an age of 80-120 years or more, several species of arboreal marsupials will be uncommon and this may be coupled with a decline in the number of animals *per se*.

Scotts (1991) and Milledge *et al.* (1991) discuss further the values of old growth Mountain Ash forest for a range of vertebrate fauna. The views of these authors generally support the findings of the Resource Assessment Commission (1992) which indicate that it is not possible to harvest timber from old growth forests and concurrently maintain their ecological integrity.

Changes in forest structure associated with clearfelling

Fire and logging appear to be the two major forms of disturbance in Mountain Ash forests. These events have different impacts on vegetation structure particularly in terms of the number, spacing and range of types of trees with hollows, as well as the mixture of age classes that may occur on a site

(Lindenmayer *et al.* 1991c, d). Many of these differences have ramifications for wildlife conservation and some of the changes in forest structure associated with clearfelling appear to have a detrimental impact on arboreal marsupials (Lindenmayer *et al.* 1991c, d). For example, the distribution of trees with hollows in clearfelled and regenerated stands is typically clustered or clumped. This is different from forests where clearfelling has not occurred and such trees with hollows are typically randomly or regularly spaced (Lindenmayer *et al.* 1990b, 1991d). Where the spacing of such trees is clumped there is a significantly lower rate of occupancy by arboreal marsupials (Lindenmayer *et al.* 1990b). Other impacts on forest structure resulting from clearfelling that have a detrimental impact on arboreal marsupials include:- (i) the removal and reduction in number of trees with hollows, and, (ii) the modification of multi-aged stands to those that are comprised of one age class. The effects of these changes on arboreal marsupials are outlined in earlier sections of this paper.

Clearfelling and the loss of trees with hollows

Presently there is a high natural rate of collapse of trees with hollows in Mountain Ash forests (Lindenmayer *et al.* 1990d). Many mature trees that were killed or badly damaged in the 1939 wildfires are now falling over. This process is predicted to lead to a substantial decline in, and prolonged shortage of, trees with hollows in stands of regrowth Mountain Ash forest (Lindenmayer 1989; Lindenmayer *et al.* 1990d). As a result of this shortage of nest and den sites, there is likely to be a decline in all species of hollow-dependent wildlife in Mountain Ash forests (Lindenmayer *et al.* 1990d).

Clearfelling operations exacerbate the rate of loss of trees with hollows. Trees that are retained during logging often collapse soon after the completion of such operations because they are exposed to windthrow or are burnt and badly damaged by the high intensity fires that are lit to promote the regeneration of harvested

stands (Lindenmayer *et al.* 1990d; Milledge *et al.* 1991).

The absence of trees with hollows after timber harvesting sets back the time until the recruitment of new trees with cavities suitable for occupation by wildlife. Thus, clearfelling operations on a 80-120 year rotation will prolong the shortage of nest sites for wildlife and accelerate the natural rate of collapse of trees with hollows in Mountain Ash forests (Lindenmayer *et al.* 1990d).

Other potential impacts

The possible cumulative or incremental effects on populations of arboreal marsupials of several logging operations in Mountain Ash forests on an 80-120 year rotation have yet to be determined (Lindenmayer 1992). These activities may lead to forest fragmentation where remaining populations of animals may be increasingly isolated by areas of unsuitable habitat. Forest fragmentation appears to have had a detrimental impact on arboreal marsupials elsewhere in Australia (e.g. Pahl *et al.*, Laurance 1990) and on wildlife populations overseas (e.g. Lynch and Whigham 1984, Askins *et al.* 1987). The impact of several successive clearfelling operations on the long-term viability of wildlife populations are also unknown.

Retained areas in timber production forest

The value for wildlife conservation of areas of Mountain Ash forest that are excluded from timber harvesting is presently unknown. These areas include steep and rocky terrain and linear retained strips such as wildlife corridors and streamside reserves. It is important to recognise that these excluded areas may not, in many cases, provide suitable habitat for all species of wildlife. The abundance of some species of arboreal marsupials, including Leadbeater's Possum, is lower on steep sites (Lindenmayer *et al.* 1991a) and there are significantly fewer trees with hollows in such areas (Lindenmayer *et al.* 1991c). In addition, the linear configuration of retained habitat in wildlife

corridors may not be suitable for some species such as those that are small, colonial and feed on widely dispersed food (Recher *et al.* 1987, Lindenmayer *et al.* in review). Finally, the ability of wildlife to recolonise logged and regenerated forests from retained areas of forest is unknown but it may be several hundred years (Lindenmayer *et al.* 1990a) and thus longer than the interval between logging operations.

Conclusions

Clearfelling on a 80-120 year rotation will have a detrimental impact on arboreal marsupials (Lindenmayer *et al.* 1990a) and other fauna dependent on large trees with hollows such as owls, cockatoos and other species of vertebrates (Milledge *et al.* 1991, Nelson and Morris in press).

The evidence to date indicates that clearfelling on a 80-120 year rotation in Mountain Ash forests appears to:

- (1) Prevent trees from becoming old enough to develop cavities suitable for use by arboreal marsupials (Lindenmayer *et al.* 1991c) and other species (Nelson and Morris in press). Typically the age of some nest trees for several species is 3-4 times that of the present interval between logging operations.
- (2) Promote the rate of loss of trees with hollows and prolongs the shortage of such trees (Lindenmayer *et al.* 1990d).
- (3) Change the abundance, spacing, distribution and range of types of trees with hollows (Lindenmayer *et al.* 1991c, d).
- (4) Reduce populations of those species most prevalent in stands of old-growth forest (Milledge *et al.* 1991).

There may be other impacts of logging operations on the long term viability of populations of arboreal marsupials in Mountain Ash forests but these have yet to be investigated. For example, the cumulative impacts of many clearfelling operations over several 80-120 year rotations in Mountain Ash forests are unknown but may result in forest fragmentation and the isolation of areas of remaining suitable habitat.

General guiding principles for future and wildlife forest management

The management of the Mountain Ash forests in the Central Highlands of Victoria will need to ensure:

- (1) The development of forestry practices that better provide for wildlife conservation. Changes to prescriptions for timber harvesting include the retention and perpetual supply of more living trees with hollows, the provision of wider wildlife corridors and retained habitats and a suite of other measures. More appropriate forest management strategies will be those that can guarantee, on logged and regenerated sites, a greater number, range and complexity of forest age classes, particularly those in ecological maturity (Lindenmayer *et al.* 1990d, 1991a).
- (2) Greater variation in the interval between logging operations (=rotation time). Forestry prescriptions must allow some stands to grow through to ecological maturity and beyond (i.e. 400 years) (Lindenmayer 1989).
- (3) The exclusion from timber harvesting of all remaining areas of old growth Mountain Ash forest (i.e. those dating from before 1926) as well as those areas that support two or more age classes on site (Lindenmayer *et al.* 1990d). Forest management planning should prevent the fragmentation of these types of forest.
- (4) The long term legislative protection, as a nature reserve or National Park, of a large area of ash-type eucalypt forest where forestry activities are excluded (Lindenmayer *et al.* 1990a; Tanton and Norton 1991). Such an area is required because of (i) the lack of information on the long term value of retained habitats for wildlife conservation, (ii) the potential effects of forest fragmentation or other, as yet undetermined, possible detrimental impacts associated with clearfelling on an 80-120 year rotation, and, (iii) uncertainty over the long-term effectiveness of some forest

management strategies (e.g. Macfarlane and Seebeck 1991) for wildlife conservation in timber production areas (Tanton and Norton 1991).

Acknowledgments

Many scientists have made a major contribution to the several of the studies that are briefly summarised in this paper. These include: Mr. R. Cunningham, Dr. M. Tanton, Professor H. Nix, Dr. T. Norton, Dr. A. Smith and Ms. C. Donnelly. A large number of volunteers have participated in stagwatching surveys for arboreal marsupials including those from the Field Naturalists Club of Victoria, staff from the Healesville Sanctuary, Box Hill Technical College and many other institutions too numerous to mention. The assistance of all those people that have contributed to the studies in the Central Highlands of Victoria is greatly appreciated. Criticisms by several anonymous reviewers from the Department of Conservation and Environment improved earlier versions of this manuscript.

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Book Review

South West Tasmania - A Natural History and Visitor's Guide

Text and Photographs by Ken Collins

Publishers: *Heritage Books, GPO Box 1066, Hobart, Tasmania. (1990).*
ISBN 1 8751110X, 368 pages, hard cover.

This colourful, well-illustrated handbook measuring 19x13 cm. is a suitable size for carrying in the field. It is well illustrated with colourful and typical illustrations of scenery in Tasmania's southwest. The illustrations provided good background information on the subjects and useful and relevant data is given in strategically placed boxes.

The first 26 pages concentrate on the geology, especially the broad principles which have affected the area. Then follows climate and weather, and water cycle, soils and rock types, detailed geology of Frenchman's Cap (especially the part played by Pleistocene glaciation), of Mt La Perouse area (outwash plains), the Denison Range, the Mt Anne area, the western Arthur Range and precipitous Bluff.

Other sections include anthropology of the Ice-Age, the origin of Tasmanian plants (with excellent illustrations of lichens, mosses, ferns and fungi) and a discussion

of button grass flora and alpine flora. Information on animal, bird and insect life rounds out these sections. The book concludes with details walking maps of the various parks in the south west and summaries of what to see in each area.

The book is a wonderful resource for the naturalist - beautifully illustrated, packed with information and interest in all fields, with geology as the basis for treatment. It is an encyclopaedia of south west Tasmania and would be useful for any Tasmanian tourist or bushwalker for it also contains information applicable to other parts of the island. It is well-documented, thoroughly referenced and fully indexed. Ken Collins has achieved his aim 'to share his knowledge with other people... either on the spot or from the armchair track.

...so enjoy it without altering it... !

Noel W. Schleiger

Butterfly Conservation

by T.R. New.

Published by Oxford University Press Australia, South Melbourne, (1991).
Pp. i — xi, 1 — 224, soft cover, r.r.p. \$24.95 ISBN 0 19 553228 7

This latest book by Tim New discusses all the aspects of butterfly conservation, and follows on from his more general 1984 book "Insect Conservation: an Australian Perspective" and his 1987 booklet on the topic, but puts the subject into an international setting. Recently the author has become deeply involved in several international butterfly conservation projects, some under the auspices of the IUCN, writing contributions on them, and he is recognised as an expert in this field. His considerable knowledge of the subject is apparent in this book.

Insect conservation has until recently been a neglected area, although butterflies have generally held attention due to their public appeal. Insects and other invertebrates are now starting to be recognised (by non-entomologists) as very important members of the ecosystem, as evidenced by the European Charter on Invertebrates. Chapter 1 discusses this point and highlights the lack of much basic information and the taxonomic impediment. The rationale for using butterflies as indicator species for environmental health due to their charisma and the depth of our knowledge about them is covered, together with some of the practical problems involved.

Chapter 2 covers the following aspects of butterflies: classification, distribution, biology (especially the close association with plants), dispersal, population structure (giving details of how abundance may be assessed, using four Australian species as examples), and behaviour in the adults.

The causes of butterfly decline, especially those resulting from human action such as deliberate extermination, over-exploitation, habitat degradation and

destruction, pesticides, influences of collecting and pollution, are examined in Chapter 3.

Recent extinctions and actions taken to protect endangered species are covered next and some solutions such as legislation and education are explored in Chapter 4. Once the problems can be identified action can be taken to conserve the species by behavioral studies, determination of population size by methods such as transect counts, habitat ranking and the distribution patterns (including mapping). These are discussed in Chapter 5, whilst the following Chapter describes ameliorating strategies such as captive breeding, farming and re-introductions, together with site evaluation and management.

Chapter 7 gives a number of case histories of attempts to conserve butterflies in England and North America (6 each), Australia (2), and one each in New Guinea, Brazil and Europe. The next Chapter mentions how butterflies may be encouraged in towns and gardens, through the establishment of nectar producing flowers for the adults and foodplants for the larvae, to aid retention and breeding of the local species, - things anyone interested could do. The final Chapter discusses the prospects for the future, emphasising the need for preservation, protection, management and improvement of habitats; the monitoring and management of species, and education. Appendix 1 lists the IUCN Red Data Book status categories, Appendix 2 provides the formula for an artificial diet for rearing butterfly larvae, and a Glossary defining 44 technical terms follows. A Bibliography of 297 references and an index of more than five pages covering subjects and

species (scientific and vernacular names) complete the book.

Tim New has once again produced a book written in an easily read and understood style using a minimum of technical terms, with those needed being defined in the glossary. It is the first book I have seen which is devoted to butterfly conservation, but, by regarding butterflies as flagship species, it covers the principles of invertebrate conservation. It fully justifies its jacket claim to be of use to entomologists, naturalists and conservationists, and should also be of interest to students and teachers involved in environmental matters. I feel that it should be studied by those in government positions at all levels who are responsible for preparing, implementing and managing conservation programs. It incorporates in one concise volume much research reported in scattered journals over recent years and brings the reader up to date to the end of 1989. Many of the procedures mentioned will assist conservationists

interested in butterflies and other invertebrates.

I found the bibliography comprehensive and useful.

I noted two minor errors: the reference to Usher 1986 in the second paragraph of page 10 is not given in the bibliography (and should probably be as cited under Disney) where the single reference is duplicated; Figure 5.6 on page 111 shows *Heteronympha mirabilis* and should read *H. mirifica*.

I can unhesitatingly recommend the book to the audience mentioned, particularly butterfly collectors. I congratulate Tim New on this comprehensive, interesting and informative contribution to insect conservation, which I hope will foster further interest and action in that field.

David Crosby, 74 Gipps Street,
East Melbourne.

Review of Australian Butterflies: Distribution Life History and Taxonomy

by Kelvyn L. Dunn and Lawrence E. Dunn

4 parts, soft cover, A4 size, 660 pp.

Privately published by the authors, 1991. ISBN 0 646 04092 8 (set)

Parts 1 & 3 each \$26, parts 2 & 4 each \$25. Set \$102 + \$10 postage within Australia.

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corrigenda.

Mapping the Australian biota is one of the most important research tasks confronting Australian biologists and the mapping of butterfly distributions is

almost certainly the most advanced among the invertebrate taxa. A number of butterfly distribution databases are in operation in Australia including that of Prof. Roger Kitching at Brisbane University, and the Entomological Society of Victoria's ENTRECS project, which is restricted to Victoria and maps records on a grid square basis, similar to that used by the National Herbarium of Victoria. In contrast the Dunns have chosen to map butterflies using discrete points. A main

component of the Dunn & Dunn work is the resulting set of distribution maps, one for each species, genus, subfamily and family. About 87,000 records have been analysed and the data displayed on 15 x 10 cm figures of the mainland with an inset of Tasmania.

The work is intended as a supplement and update to the famous standard text by I.F.B. Common and D.F. Waterhouse, *Butterflies of Australia* (Revised Edition, Angus & Robertson, 1981; Field Edition, 1982), the limitations of which (inadequate referencing, partly hypothetical distribution maps) have become apparent in the decade since its publication. Common and Waterhouse recognised 382 butterfly species from Australia, Dunn and Dunn recognise 396 (page 2), plus *Mycalesis evara* (p.529) a vagrant from New Guinea.

The text was written entirely by Kelvyn, with Lawrence being responsible for the maps, most of the charts and for design of the database, written in FOXBASE+ with a search system written in machine code.

Eleven pages of preface and introductory remarks explain the origin of the work and the methodology (very little on computing and cartographic aspects), detail the collections examined and data supplied by collectors, and acknowledge the extensive collaboration of amateur and professional entomologists in providing reference specimens and materials. Data is incorporated on material in the Australian National Insect, James Cook University, Museum of Victoria, South Australian Museum and Victorian Agricultural Insect and Arachnid Collections, but collections of other major state institutions, although referred to, were not examined. Specimen and observational data from about 30 private collectors is incorporated along with information available in hundreds of published papers, books and notes, and the authors' own extensive records. Many papers additional to those referenced were consulted but, for the purposes of defining known distributions, only works including

extreme points of a species' range are included.

Part 1 contains the adult temporal data charts, the first time such information has been systematically provided for Australian species. The authors overlay B.A. Barlow's 33 natural botanical regions and 6 floristic zones onto the butterfly distributions to generate two sorts of charts: bar graphs showing the number of species recorded (in the adult stage) in each region during each month, and tabular charts listing each species with a breakdown of the number of records (2 or more, 1, 0) of that species for each month. The richest region by far is Cape York with 285 species while the most impoverished (or least explored) is Gibson (Desert) which lacks a single record.

The main text in each volume provides details of the limits of distribution of each species and subspecies (citing primary authorities or reference collections with the Museum data given priority listing over publications), and provides clarification, corrective comments and details of excluded data. Like Common and Waterhouse the authors accept that the distribution of the well known Caper White includes the whole of the mainland but their map shows only a single record between Spencer Gulf and Shark Bay, an area covering approximately one quarter of the continent. Clearly lepidopterists have a great deal more recording yet to do. For many species the morphological variation and taxonomic status is then discussed. In several cases it is argued that subspecies are based on extreme examples of a very variable population, that there is no geographical discontinuity between the nominal subspecies and that continued recognition of such taxa is no longer appropriate. These taxonomic opinions appear to be largely uncontroversial and overdue.

Where new life history information and ecological data has been discovered since Common & Waterhouse this is then detailed. The Meadow Argus and the Blue Argus, for example, are now recognised as displaying seasonal polymorphism, with

the dry season forms having more cryptic underwing patterns.

Reference lists (with book but not article titles) are provided separately for each family which means there is considerable duplication in terms of the work as a whole.

Part 4 contains a larval food plant/host catalogue which includes a number of previously unpublished hosts and totals 24 pages including references. The botanical names have not been systematically updated and follow Common & Waterhouse so that, for example, the food plants of *Vanessa kershawi* cited as *Gnaphalium spicatum*, *Helichrysum bracteatum* and *Hapiculatum* should have been cited as *G. purpureum*, *Bracteantha bracteata* and *Chrysocephalum apiculatum*. This final part concludes with 2 pages of new information and 2 pages of corrigenda gathered during the publication phase of the set.

The work lacks an index which makes it less easy to use than it could be, even for the expert who knows the systematic position of each species in its family. Common names have not been included although the great majority of species do have them and they are widely used. There are no illustrations of the species recorded since Common and Waterhouse. A little bit of extra work could have enabled sufficiently diagnostic black and white pictures to be included and this would have improved the value and marketability of the work. The layout is clumsy in places and larger print would have been better for the species headings. More detail of the

methods and resolution with which distribution points are marked would have been interesting and lack of information on the mapping is probably the book's worst feature.

Some workers will be annoyed to find that their publications have been overlooked along with the new information they contain and I am disappointed that more of the early reports (e.g. J.A. Kershaw's 1906 and 1913 lists for Wilsons Promontory in the *Victorian Naturalist*) have not been cited, especially when they detail distribution extremes claimed as the authors' own. Many published works in the vast butterfly literature, especially minor notes and small articles in local naturalist newsletters, remain to be integrated into the total picture but the reference lists provided by this work make these much easier to identify.

This book is a very detailed and well organised work, an essential reference for any person working on Australian butterflies. In the great traditions of amateur research it was entirely privately funded and produced and is the more remarkable for this. Only a small print (100) run was made and the set will be difficult to acquire in the future. This is a pity because the work will prove to be an extremely useful reference tool and will provide a strong impetus to more thoroughly document all details of our diverse Hesperoidea and Papilionoidea.

Ian Faithfull, 7/20 Adam Street,
Burnley, Vic., 3121

CAN YOU HELP?

The Club has no copies of the Victorian Naturalist Vol. 108 No. 2 and several are urgently needed for binding into volumes and other purposes.

If you can spare your copy of Vol. 108 No. 2 please leave it at any General Meeting or Group Meeting or forward direct to my address:

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Obituary

A Tribute to the late Frederick Stanley Colliver (1908-1991)

Our Field Naturalist Club has never known a more devoted or dynamic member than Stan Colliver who died at Brisbane on 25 September 1991, aged 83. A sensitive, fairly detailed obituary appeared in *The Queensland Naturalist* (Vol 31: 49-53) earlier this year. Stan had been a member of the Queensland Club for 43 years, serving for most of that time as a Councillor, and it is only proper to make reference in *The Victorian Naturalist* to his sterling work for the FNCV during earlier days (1931-1948), whereby he was awarded honorary membership.

Elected an ordinary member in June 1931, F.S. Colliver became Honorary Secretary two years later, retaining that onerous position for almost 15 years, until his resignation in April 1948 to take up a scientific post in the Geology Department, University of Queensland. His chief interests were rocks, minerals, fossils and mollusc shells, in each of which he built up an immense private collection. For example, his Tertiary fossils numbered about 200,000 items that were presented to the Museum of Victoria, while his gatherings of shells (an estimated 400,000 items) went to the Queensland Museum which also received 5,000 geological specimens. Over the years (1932-1959 inclusive) Stan Colliver contributed 28 articles to the present journal, none more important than a five-part series in 1937 on 'Fossil localities in and about Melbourne' (Vol 53: 131, 151, 197; 54: 80, 107). He travelled widely in Australia, labelling all his collections with meticulous care, and he was an admirable leader of many FNCV excursions.

He married Mary Ferguson in 1940, and during the 1940's it was my privilege to be accepted as one of the "gang" - a kind of inner sanctum for club members who would meet at the Collivers' home in Essendon on Sunday afternoons. We soon realized the need for an author index to *The Victorian Naturalist*, and a "gang" working bee was initiated to prepare the necessary card index of references - following an agreed format.

One can fully endorse the eulogistic comments of our sister Club in Brisbane concerning their lamented member: with a bubbling sense of humour, Stan was *always* a gracious, kindly, gentle, sympathetic, very hard-working and an ever-youthfully enthusiastic companion, whom it was indeed one's honour to know. At his farewell function during The FNCV meeting of April 12 1948, Stan was presented with a kangaroo-hide wallet of money in appreciation of his long and invaluable services - about 250 members and friends were present. Despite the move he regularly visited Melbourne and, at the Club's Centennial Celebrations in 1980, addressed a special Club meeting at the State Film Centre.

His name is perpetuated in that of the fossil toothed whale, *Mammilodon colliveri*, the lower jaw of which he found near Geelong about 1939; and, in startling contrast, a minute endemic land mollusc (shell only 2-3 mm wide) that he discovered in wet forest land of the Gippsland Lakes region, was given the binomial *Cralopa colliveri* (Gabriel, 1947).

J. H. Willis

The Field Naturalists Club of Victoria

In which is incorporated the Microscopical Society of Victoria

Established 1880

Registered Office: FNCV, c/- National Herbarium, Birdwood Avenue, South Yarra, 3141, 650 8661.

OBJECTS: To stimulate interest in natural history and to preserve
and protect Australian fauna and flora.

Members include beginners as well as experienced naturalists.

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His Excellency, The Honourable Richard E McGarvie, The Governor of Victoria.

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Membership of the F.N.C.V. is open to any person interested in natural history. *The Victorian Naturalist* is distributed free to all members, the club's reference and lending library is available and other activities are indicated in reports set out in the several preceding pages of this magazine.

Membership rates 1992

Metropolitan	\$30
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Concessional rate (Students/pensioners)	\$22
Joint Concessional	\$27
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Subscription rates 1992

Club subscription	\$30
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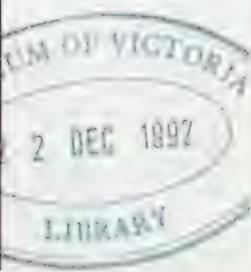
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The Victorian Naturalist

Volume 109 (6) 1992

December



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FNCV Calendar of Activities

December

Sat 26 - Sat 2

Fauna Survey Group Field Survey. Jilpanger Scrub Flora and Fauna Survey. Contact Felicity Garde, 808 2625.

January

Wed 20

Microscopy Group Meeting. Members night. Astronomer's Residence 8 p.m.

Sat 23 - Mon 25

Fauna Survey Group Field Survey. Wilsons Promontory (post-fire ecology study). Contact Anne Casey, 379 1611.

February

Tues 2

Fauna Survey Group Meeting. Herbarium Hall 8 p.m.

Wed 3

Geology Group Meeting. Herbarium Hall 8 p.m.

Mon 8

General FNCV Meeting. The work of ANZSES - the exploring society - Roger Pierson. Herbarium Hall 8 p.m.

Thurs 11

Botany Group Meeting. Speaker - David Cameron. Herbarium Hall 8 p.m.

Sat 13

General FNCV Excursion. Marine Rock Platforms at Point Roadknight near Anglesea. Leader Dr. Geoff Wescott. Transport by bus for 12 people \$20, some lifts can be arranged, contact Dorothy Mahler, 435 8408. **Please note date changed due to time of low tide.**

Wed 17

Microscopy Group Meeting. Top lighting for microscope slides. Exhibition of Club's opaque slides. Astronomer's Residence 8 p.m.

Sat 27

Botany Group Excursion. Coastal Peninsula. Leader Tom Sault. Contact Joan Harry, 850 1347.

March

Fri 19 - Sun 21

Excursion. Volcanoes of West. Vic. See Newsletter for details.

The FNCV at work - Wattle Park, Burwood

We are pleased to report that a proposal to Melbourne Water to build an 'American-style' playground at Wattle Park has been withdrawn. This was due in no small part to the active work by members of the Club and other groups.

The Club has had a long association with Wattle Park from its inception in 1917 and Council was anxious to see the natural history value of the park retained.

At the request of the Club, a major report was prepared by Ian Faithfull and submitted to Melbourne Water. It played a significant part in their decision and a copy is held in our library for members to read.

Thanks are due to all the organisations and people involved in the discussions and especially to Ian Faithfull.

Thank you from the Editors

The editors would like to thank both our authors and referees for their time, effort and assistance in preparing papers for publication in *The Victorian Naturalist*. Its quality and reputation largely depends on your co-operation and we look forward to your continued support.

The Victorian Naturalist



Volume 109 (6) 1992

December

Editor: Robyn Watson

Assistant Editors: Ed and Pat Grey

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Benthos of the Muddy Bottom Habitat of the Geelong Arm of Port Phillip Bay, Victoria, Australia.

Janet M. Carey and Jeanette E. Watson*

Introduction

The subtidal benthos of the Geelong Arm of Port Phillip Bay is known from taxonomic descriptions and species lists from the National Museum of Victoria Survey of Port Phillip Bay 1969 - 1971 (Black 1971), and from surveys of the benthos of Port Phillip Bay by the Melbourne & Metropolitan Board of Works and the Fisheries and Wildlife Department 1968 - 1971, (M&MBW Study, 1973, see Poore *et al.* 1975). These latter surveys, which sought to define the populations and distribution of the infaunal benthos of Port Phillip Bay, included some stations in the Geelong Arm (Poore and Rainer 1974, 1979). Other than monitoring the scallop populations off Portarlington for the commercial fishery (e.g. Smith and Bury 1991), there have been no quantitative studies of the distribution of the soft bottom epibenthos of this area. The present study deals with the species, abundance and distribution of both the infauna and selected epibenthos of the muddy habitat of the Geelong Arm.

Environment of the Geelong Arm

The central axis of the Geelong Arm comprises three basins: the well-defined Corio Bay (to 9 m depth), and two, less well-defined in Outer Harbour, one extending from Point Henry to Point Wilson (to 8 m depth), and the second merging eastwards from Point Wilson into wider Port Phillip Bay between Portarlington on the Bellarine Peninsula and Little River on the northern coast (to 11 m depth) (Fig. 1).

Water circulation in the Geelong Arm is driven by both tide and wind; peak tidal flows being generally less than 20 cm/s, water movement decreasing westwards into Corio Bay. Strong north-easterly and

westerly winds may induce surface current speeds of up to nearly 50 cm/s (A. McCowan, pers. comm.)

The sea bed of the central axis of the Geelong Arm is uniformly flat and topographically featureless, the sediments consisting of semi-compacted grey clay mixed with varying proportions of aged to sub-fossil shell.

Sampling of the benthos was undertaken in February-March 1992 in six fixed areas and at 24 randomly chosen sites within these areas (Fig. 1). Sampling sites were positioned by Global Positioning System (GPS).

Epibenthos

Most of the dominant epibenthos of the muddy bottom of the Geelong Arm are species common to similar habitats in Port Phillip Bay.

Plants include sparsely distributed patches of the marine angiosperm *Halophila australis* Doty & Stone and the green alga *Caulerpa remotifolia* Sonder. Common sessile invertebrates include several species of sponges, the ascidians *Pyura stolonifera* subsp. *praeputialis* Heller and *Sycozoa pedunculata* (Quoy and Gaimard), and a colonial polychaete provisionally identified as *Sabella spallanzanii* Gmelin. Motile animals include the holothurian *Stichopus mollis* (Hutton), the sea stars *Patiriella brevispina* H.L. Clark and *Tosia australis* Gray, and the commercial scallop *Pecten alba* Tate. The fragile bivalve *Electroma georgiana* (Quoy and Gaimard) and the hydroid *Obelia australis* Lendenfeld are seasonally common (Watson unpubl.), and large populations occurring over the summer months.

Methodology

Selected visually dominant and easily quantifiable epibenthic species were

* Marine Science & Ecology Environmental Consultants, 35 Tilba Street Essendon Australia 3040.

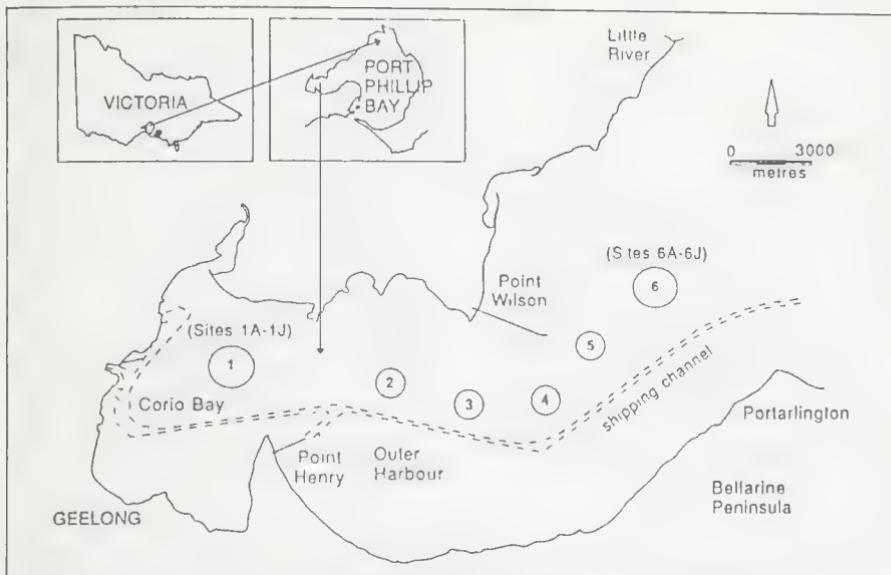


Fig. 1 Map showing location of sampling areas and sites in the Geelong Arm of Port Phillip Bay.

counted by a biologist-diver at each site. Leaf density of *Halophila australis* was estimated over four randomly placed replicate quadrats each of 0.25 m², the number of leaves in each quadrat being counted. Colonies of *Sabella spallanzanii* were quantified by recording the intercept distance covered by each colony along a 25 m line transect. Individuals of *Pyura stolonifera* were counted over a belt transect of 25 x 1 m, and scallops over a similar transect of 50 x 1 m.

The multivariate technique of non-metric multidimensional scaling (NMDS) was used to provide an insight into distribution of the epibenthos. The ordination was based on a dissimilarity matrix of Manhattan distance measures, where distance (x_y) = $\sum_i |x_i - y_i|$.

Results and Discussion

Halophila australis was present in quantifiable densities only in Area 1 in Corio Bay (Table 1). Although isolated plants were observed at some of the easterly areas, none were recorded from the quadrats. Leaf densities in Area 1 ranged from 0-445/m² with a mean density of

131/m² (SD = 158). Plants were most abundant in the south-east of Area 1 (Sites 1B,D,H,J). This area has relatively greater tidal and wind-generated water circulation than most of Corio Bay.

Halophila australis is a cool temperate species ranging from the South Australian gulfs to New South Wales (Shepherd 1983; Shepherd and Robertson 1989; Robertson 1984). Plants are pioneer colonisers of barren areas (Walker 1989; Clarke and Kirkman 1989). In sheltered Victorian waters growth of *H. australis* is limited by irradiance to a depth of about 8 m. It prefers muddy or silty bottom, often occurring as a sparse fringe on the seaward side of *Heterozostera* meadows (Bulthuis 1981). It occurs along the northern and southern coastlines of the Geelong Arm and in Swan Bay on the eastern side of the Bellarine Peninsula (Black 1971). It is a seasonal plant (West *et al.* 1989) with maximum growth over the summer months (H. Kirkman pers. comm.). The plants grow from a slender stolon embedded in the substrate, the shoots bearing paired leaves (Robertson 1984).

The polychaete *Sabella spallanzanii* is the visually dominant organism of the muddy bottom habitat. The colonies distributed in patches, consist of closely aggregated clusters of one to 30 individuals growing to a height of about 30 cm above the substrate (Fig. 2). Each silt-coated tube is surmounted by a crown of buff-coloured feathery brachioles. Masses of green-coloured eggs are released in late summer.

The mean number of colonies per transect over all sites was 8 (SD = 7) (Table 2), approximately equivalent to one colony every 3 m. In Corio Bay (Area 1) the number of colonies varied from 0 in shallower water (Sites 1B, II) to 22 at Site 1C in quieter water, the mean number of colonies per transect being 10 (SD = 8). In Outer Harbour, the number of colonies ranged from one (Site 6F) to 27 (Site 3) with a mean of 7 colonies per transect (SD = 7).

Table 1. Distributional data of selected species, Geelong Arm

Halophila australis	- no. of leaves per m ²
Pyura stolonifera	- no. per 25 m transect
Pecten alba	- no. per 50 m transect

Area / Site	Halophila australis	Pyura stolonifera	Pecten alba
1A	0	0	0
1B	186	0	0
1C	0	2	0
1D	278	1	0
1E	0	0	0
1F	49	0	0
1G	52	0	0
1H	445	5	0
1I	14	0	0
1J	288	2	0
2	0	2	5
3	0	3	0
4	0	5	74
5	0	29	152
6A	0	128	31
6B	0	0	47
6C	0	11	18
6D	0	2	20
6E	0	16	109
6F	0	11	85
6G	0	36	18
6H	0	5	85
6I	0	68	39
6J	0	86	16
Total	1312	412	699
Mean	55	17	29
SD	119	32	42



Fig. 2 Photograph of sea bed in Corio Bay showing colonies of *Sabella spallanzanii*. Depth 4 m.

Mean colony width over the entire survey area was 9.6 cm, that in Corio Bay being 11.4 cm, and in Outer Harbour, 6.4 cm. The largest colonies recorded, with a mean width of 50 cm, occurred at Site 2 in Outer Harbour.

Sabella spallanzanii has not previously been recorded from Australia (e.g. Pollard and Hutchings, 1990); it is known from the Mediterranean Sea, the English Channel, North Africa, Rio de Janeiro, and south-east Asia (Knight-Jones, pers. comm.). It is not recorded from earlier surveys of Port Phillip Bay, nor was it seen in Corio Bay by the authors or others (A. Stevens, pers. comm.) before the early 1980s. Its present density and visual dominance suggests that it may be an introduced species that has proliferated in the muddy habitat and calm environment of the Geelong Arm. The tubes of the larger colonies provide habitat for many sessile species (filamentous red algae, hydroids) and sedentary species (gastropod molluscs, sea stars, crustaceans) common in Port Phillip Bay. If indeed introduced, there is not apparent evidence of it having displaced any indigenous species from their habitat.

Mean populations of *Pyura stolonifera* varied from 1/25 m² (SD = 1) in Area 1 to 29/25 m² in Outer Harbour, with a mean density of 17/25 m² (SD = 32) over the entire survey area (Table 1). The highest population was at Site 6A where a mean density of 128/25 m² was recorded.

Pyura stolonifera is one of the most abundant and widely distributed ascidians in embayments along the southern Australian coastline, being recorded from south-western Australia to southern Queensland (Kott 1976). It is especially abundant in Port Phillip Bay and Western Port (Millar 1966; Black 1971; Watson unpubl.) where it colonises a range of sediments from compacted muds to sandy bottom. Larvae settle on old shell and mature in one to two years to either solitary, or clusters of individuals that may stand more than 10 cm above the substrate. The leathery test of the adult organism provides substrate for a wide variety of algae and sessile invertebrates. In many parts of Port Phillip Bay where reef habitat is absent it is an important primary substrate, forming numerous 'micro-reefs' which are substrate for many other species (Watson unpubl.). Its importance as substrate and habitat for epibenthic organisms in otherwise barren areas of the bay has never been explored.

Table 2. Total intercept length (cm), number, mean width (cm) and standard deviation of *Sabella spallanzanii* colonies per 25 m line transect.

Area/Site	1A	1B	1C	1D	1E	1F
Intercept	136	0	234	167	60	71
Number	8	0	22	14	4	17
Mean width	17	0	11	12	15	4
Std.dev.	19	0	15	14	27	6

Area/Site	1G	1H	1I	1J	2	3
Intercept	372	2	0	87	150	88
Number	16	1	0	17	3	27
Mean width	23	2	0	5	50	3
Std.dev.	37	0	0	6	69	4

Area/Site	4	5	6A	6B	6C	6D
Intercept	92	175	21	12	2	38
Number	8	9	14	4	2	4
Mean width	12	19	2	3	1	10
Std.dev.	12	25	1	3	0	8

Area/Site	6E	6F	6G	6H	6I	6J
Intercept	25	2	30	3	90	64
Number	5	1	8	3	7	7
Mean width	5	2	4	1	13	9
Std.dev.	6	0	5	0	14	8

Density of *Pecten alba* ranged from 0 to 150/50m² at Site 5, with an overall mean of 29/50m² (SD = 42) (Table 1). No scallops were recorded from Area 1. At Sites 6A-6J off Portarlington, mean density was 47/50m². All scallops were about 70 mm in width and thus about 18 months old (Gwyther and McShane 1988). The difference between the mean population density recorded in the present survey and the mean of 0.09/m² found in the Geelong Arm by Smith and Bury (1991) may be due to distributional patchiness, suggested by the large standard deviation (Table 1).

The NMDS ordination, using the number of colonies of *S. spallanzanii*, shows sites with highest plant density of *H. australis* on the right hand side of the plot (Fig. 3). These sites are shallow and

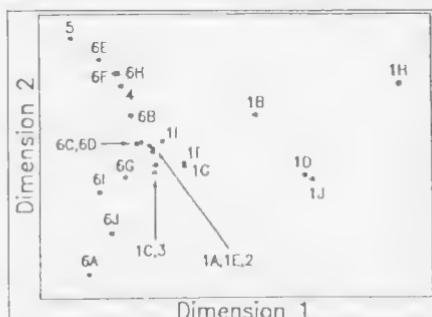


Fig. 3 NMDS ordination of sites on basis of epibenthos (stress = 0.02).

are the ones most exposed to water movement in the entire survey area. The mutual exclusivity shown between *H. australis* and scallops (see also Table 1) is probably indicative of increasing water depth eastwards in the Geelong Arm. The general increase in *P. stolonifera* numbers and decrease in size of colonies of *S. spallanzanii* eastwards from Corio Bay suggests that the former requires good water movement while the latter prefers quieter conditions.

With the possible exception of *S. spallanzanii*, the epibenthic community of the Geelong Arm consists of species common throughout Port Phillip Bay. However, the relative abundance of the species comprising the community probably differs from other parts of the

Bay. However, the relative abundance of the species comprising the community probably differs from other parts of the bay. Unlike the meadow-forming seagrasses of the Zosteraceae bordering much of the Bellarine coastline, the small size and sparse cover of plants of *H. australis* makes it unlikely that this marine angiosperm is an important fish habitat.

Infauna

Methodology

At Sites 1A, 1J, 2, 3, 4, 5, 6D and 6G, infauna was sampled from an area of 0.1m^2 to a depth of 10 cm by a biologist-diver using a water-venturi suction sampler. Samples were sieved through a mesh of 710 μm and preserved in a 10% formaldehyde solution. In the laboratory, organisms were sorted from the sediment matrix, identified to higher taxonomic group under stereomicroscope and counted.

An NMDS plot of Manhattan distance measures, similar to that used for epibenthos, was used for interpretation of infaunal distribution.

Results and Discussion

The infauna comprised the major phyla normally associated with soft bed habitat. The number of species per site of 0.1m^2 ranged from 41 (Site 6D) to 74 (Site 3) with a mean of 52 ($SD = 10$).

Table 3. Distributional data of infauna, Geelong Arm. Number of organisms and species per site of 0.1m^2

Taxon	1A	1J	2	3	4	5	6D	6G	Mean	SD
Mollusca										
organisms	273	274	5	47	118	89	36	65	113	104
species	6	5	4	9	8	6	5	6	6	2
Polychaeta										
organisms	352	633	602	475	356	487	142	245	412	170
species	17	22	20	33	18	16	19	19	21	5
Crustacea										
organisms	94	94	119	309	605	587	467	469	346	221
species	17	13	17	21	18	18	14	22	18	3
Echinodermata										
organisms	14	5	24	56	29	12	0	1	18	19
species	3	3	3	3	3	3	0	1	2	1
Minor Groups										
organisms	32	45	84	28	88	77	73	20	56	28
species	4	4	8	8	6	5	3	5	5	2
Total										
organisms	765	1051	834	915	1196	1252	718	827	945	200
species	47	47	52	74	53	48	41	53	52	10

Populations ranged from 718 at Site 6D to 1252 at Site 5 with a mean of 945 ($SD = 200$) (Table 3).

Polychaetes were the predominant group with 44% of the overall population and a mean of 21 species per 0.1m^2 (Fig. 4).

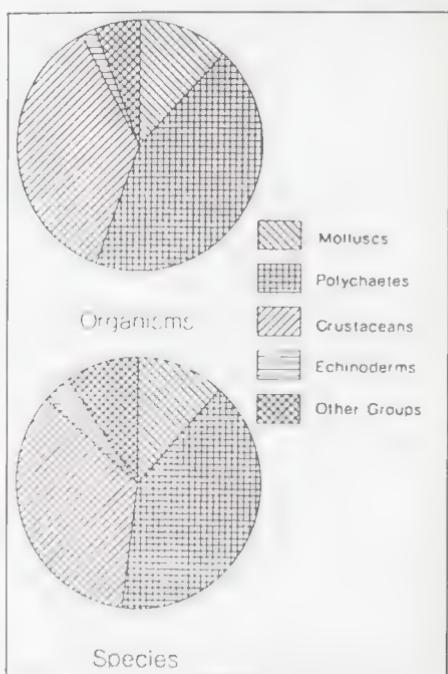


Fig. 4 Pie diagrams showing species composition and abundance of the infauna in Geelong Arm.

Population densities ranged from 142 (Site 6D) to 633 (Site 1J) with a mean of 412 ($SD = 170$). The most numerous polychaetes were *Nephtys inornata* Rainer & Hutchings, *Tharyx* sp., *Leitoscoloplos bifurcatus* Day, *Armandia* sp. and *Polyopthalmus pictus* (Dujardin).

Crustaceans were the next most abundant group with 37% of the populations and a mean of 18 ($SD = 3$) species per $0.1m^2$. Population densities ranged from 94 organisms per site (Sites 1A, 1J) to 605 (Site 4) with an overall mean of 346 ($SD = 221$). The predominant crustacean was the cumacean *Dimorphostylis cottoni* Hale, which comprised 24% of the total infaunal population over the entire survey area; it was most abundant at Sites 4, 5, 6D and 6G in Outer Harbour but was rare in Area 1.

Molluscs were the third most abundant group with 12% of the population and a mean of 6 species ($SD = 2$). Population densities ranged from 5 (Site 2) to 273 and 274 (Sites 1A and 1J) with a mean of 113 ($SD = 104$). Bivalves were the dominant molluscan group, the high numbers in Area 1 being mainly due to *Theora lubrica* Gould. The nesting mussel *Musculista senhousia* (Benson in Cantor), was common at Site 1J. Other common bivalves were *Fulvia tenuicostata* (Lamarck 1819) and *Tellina mariae* (Tennison Woods 1875). *Anisodonta subalata* (Gatliff and Gabriel 1910) from Site 6G is a rare species. Juvenile opisthobranchs *Liloa brevis* (Quoy & Gaimard), were recorded in numbers ranging from 13 to 72 at various sites. Gastropods were rare and represented mainly by *Diala lauta* Adams.

Echinoderms comprised 2% of the populations with a mean of 2 species at each site while the minor groups, with 4% of the populations were present with at least eight species groups. The most abundant echinoderms were the ophiuroids with a mean of 16 individuals per site. Echinoids, represented solely by the burrowing species *Echinocardium cordatum* (Pennant), were uncommon, but

were more plentiful in Area 1 than elsewhere.

The NMDS ordination (Fig. 5) shows a separation along Dimension 1, between sites east of Point Wilson and those to the west. This division may be attributable to greater water exchange at these sites with wider Port Phillip Bay.

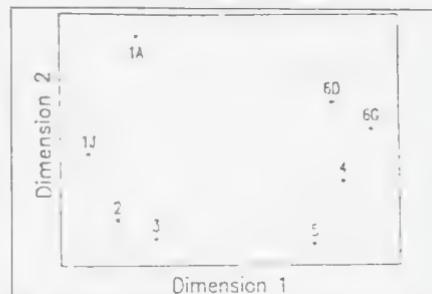


Fig. 5 NMDS ordination of sites on basis of infauna (stress = 0.02).

Five stations sampled for infauna in the Geelong Arm by the M&MBW Study (1973) (Poore *et al.* 1975), are geographically comparable to the present study. These authors gave a range of 118-462 organisms/ $0.1m^2$ and 57-87 species per site of $0.5m^2$. Sampling on 11 occasions of one site in Corio Bay (Stn 940) near Sites 1A and 1B of the present survey (see Table 3) between 1973 and 1975, resulted in an overall mean of 89 organisms and 19 species/ $0.1m^2$ (Poore and Rainer 1979). Since seasonal variation in populations was determined to be insignificant by these authors, the much greater infaunal populations recorded in the present study may be due to more intensive sampling techniques.

Musculista senhousia was introduced to Western Australia from Asia or New Zealand about 1982 (Willan 1987). *Theora lubrica*, also introduced from Asia (Chalmer *et al.* 1976), was probably recorded as *Theora fragilis* by Poore and Rainer (1979).

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Survey for the Spotted Tree Frog (*Litoria Spenceri*) in Victoria, February-March 1992

By Graeme R. Gillespie*

Introduction

This report presents the results of the first of a two-part survey for the nationally endangered (ANZECC 1991) Spotted Tree Frog in north eastern Victoria, and provides some direction for future study of this species. The second component will be conducted in spring and summer, 1992. Objectives of the survey are: (1) to re-assess the status of the Spotted Tree Frog at sites where the species was believed to have disappeared; (2) to conduct on-going monitoring of the population on the Taponga River and (3) to investigate selected areas for new populations.



Fig. 1. Spotted Tree Frog (*Litoria spenceri*), Goulburn River, Central Highlands, Victoria. (Photo: Graeme R. Gillespie).

Methodology

The bulk of the work in this first survey was conducted between 18-28 February and 2-13 March, 1992. Some additional sampling was carried out along the Big River (Mitta Mitta) and Lightning Creek and Snowy Creek in January and late March (Johnson 1992). Because of insufficient time it was not possible to investigate all historical localities or previously unsurveyed potential habitats in this survey. Historical localities which had not been intensively surveyed in 1991 were

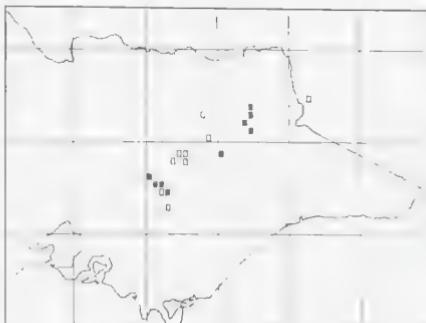


Fig. 2. Five minute grids in which Spotted Tree Frogs have been recorded. Solid grids represent records since 1989. Open grids represent records prior to 1984 (Atlas of Victorian Wildlife; Watson *et al.* 1991; this study).

targeted, along with a selection of unsurveyed streams, chosen on the basis of habitat and access.

Sampling was restricted to the immediate stream environment (i.e., between each vegetated bank). All microhabitats along banks and within the stream were investigated by day, giving particular attention to those in which the species had previously been recorded. Some streams were also investigated at night with a portable spotlight for active frogs. A minimum distance of 500m was searched along each stream visited.

All frogs encountered were identified, and their microhabitat and activity recorded. With the exceptions of populations on the Goulburn River and the Black River, and individuals located on the Big River (Eildon), all specimens found were weighed (to nearest 0.1gm), measured (to nearest 0.1mm), and individually marked by toe-clipping (after Hero 1989). Any secondary sexual characteristics, such as swollen nuptial pads or a pigmented throat, were also recorded. Because of the large number of individuals located and the small amount of time available only a proportion (50%) of the individuals

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observed were marked, weighed and measured on the Goulburn River and the Black River. Tadpole and frog specimens were lodged with the Museum of Victoria.

Individuals were classified into age-classes on the basis of snout-vent length and presence of secondary sexual characteristics. The age-classes used have been derived from museum specimens of known sex (Watson *et al.* 1991) and age/size data collected for the Taponga River population prior to this survey (Hero and Robertson unpubl. data). The age-classes are as follows:

Snout-vent <20mm Juvenile
Snout-vent 20mm-32mm, no swollen nuptial pads Sub-adult
Snout-vent >25mm, swollen nuptial pads Adult Male
Snout-vent >32mm, no swollen nuptial pads Adult Female

These are arbitrary divisions which should be interpreted with caution. Sexual differentiation in this species has not been fully characterised, and some individuals may be incorrectly diagnosed. For example, larger males could be confused with females if nuptial pads of sexually mature males do not remain swollen through March, or if some males in the population exceeded 32mm (SVL) before showing any sexual differentiation. However, the classification does allow approximate comparisons of age-structure between populations.

Results

Spotted Tree Frogs were located along eight of the sixteen streams and twenty nine localities sampled (Table 1). Three of these streams, the Black River, Goulburn River and Snowy Creek, are new localities for the species. Spotted Tree Frogs had previously been recorded on the other four streams however, on three of these the species had not been seen since 1984 (Watson *et al.* 1991).

Characteristics of the size and age-structure of the populations of Spotted Tree Frog surveyed are summarised in Table 2 and details are presented below. Several

of the streams on which Spotted Tree Frogs were located are connected. The Black River is a major tributary of the Goulburn River; the Still Creek is a tributary of the Taponga River; the Taponga River is a tributary of the Big River (Eildon); and the Lightning Creek is a tributary of the Snowy Creek. Where the distribution of frogs was continuous along two connecting streams, the data have been combined.

Goulburn and Black Rivers

A large population was located along these rivers, extending almost continuously for at least 2km above and below their confluence. Two juveniles were also recorded approximately 14km down stream on the Goulburn River at Lazarin's Track. No Spotted Tree Frogs were located at Woods Point during this survey. Spotted Tree Frogs were last recorded on the Goulburn River at Woods Point in 1969 (Watson *et al.* 1991).

Snowy Creek

During this survey and that of Johnson (1992), Juveniles were recorded along several stretches of Snowy Creek extending from the Bogong Branch, approximately 1km above the confluence with Mount Wills Creek, to 2km below the confluence with Lightning Creek. Distribution was patchy. Extensive searches conducted further down stream on Snowy Creek in late March failed to detect the species (Johnson 1992). No frogs were found along Mount Wills Creek. The species has not previously been recorded from Snowy Creek (Watson *et al.* 1991).

Lightning Creek

Twelve juveniles were located along a 100m stretch of the stream, and within 200m of the previous record in 1983, 4km up-stream from Snowy Creek. Sections of Lightning Creek were searched well up-stream from where the frogs were found, including stretches up-stream from any eductor dredging areas. Juveniles were also located at the confluence of Lightning and Snowy Creeks. These have been included in the data from Snowy Creek but may

have arisen from Lightning Creek. One adult and 20 juveniles were previously recorded approximately 4km up-stream from Snowy Creek in 1983 (Watson *et al.* 1991).

Big River (*Mitta Mitta*)

Individuals were located along several stretches of this river, extending from the Alpine National Park boundary 12km down stream to the vicinity of the 1983 record (Watson *et al.* 1991). The majority of individuals were sub-adults, most of which were recorded along a 3km stretch down-stream from the park boundary. Two of the three adults and most of the juveniles encountered occurred down stream near the 1983 record. Nine tadpoles were collected, five at the upper-most locality, just outside the Alpine National Park. This finding extends the known altitudinal range of the Spotted Tree Frog from 800m (Watson *et al.* 1991) to 915m above sea level. No frogs were found along Wild Horse Creek. The species was previously recorded on the Big River approximately 3km down-stream from the confluence with Wild Horse Creek in 1983 (Watson *et al.* 1991).

Big River (Eildon)

Two juveniles were recorded above Enoch Falls and one sub-adult was located 15km up stream near 25 Mile Creek. No Spotted Tree Frogs were located on the Big River near Taponga River. The species was previously recorded approximately 50m down-stream from the Taponga River in 1979 (Watson *et al.* 1991). Two tadpoles collected from Enoch Falls in 1990 were recently confirmed as Spotted Tree Frog Tadpoles (Hero *et al.* in prep.).

Taponga River and Still Creek

A population of Spotted Tree Frogs on the Taponga River has been surveyed bi-annually over the past two years (Hero and Robertson unpubl. data). The area surveyed during this visit extended upstream from the Big River on the Taponga River and Still Creek to approximately 1km above the Eildon-Jamieson Road. The total abundance and distribution of Spotted

Tree Frogs observed during this survey was similar to that recorded during previous searches (Hero and Robertson unpubl. data).

No frogs were found along the Howqua River and King River, providing further evidence that the Spotted Tree Frog is extinct along these streams.

Relative Abundance

The largest number of individuals (187) was recorded along the Goulburn River and the Black River (Table 2). This population also had the highest density, indicated by the number of individuals per 100m of stream searched. The full extent of this population along these rivers was not ascertained during the survey. Very few frogs were found towards the upper limit surveyed in this section along the Black River, however this may reflect the absence of shingle banks and other suitable habitats. The location of two juveniles 14km further down stream on the Goulburn River during a short search suggests that individuals may be distributed over a much longer stretch of the Goulburn River than was examined during this survey.

The lowest number of individuals (three) was recorded on the Big River (Eildon). This stream also had the lowest density of Spotted Tree Frogs. However, only 1.5km of stream was searched, most of this down stream from where the frogs were found. Consequently, the distribution of frogs further up stream has not been ascertained.

Lightning Creek also supported very few individuals (12). In contrast to the other streams, these were only found along a short stretch of approximately 100m, despite intensive searches 500m both up-stream and down-stream from this area.

Age Structure

The population age-structure varied markedly between streams at the time of survey (Table 2). Juveniles (55.6%) were the most abundant age-class. Juveniles comprised a substantial component of all populations, and were the only age-class recorded along the Snowy and Lightning Creeks. Sub-adults made up 28.3% of all

Table 1. Details of localities surveyed for Spotted Tree Frogs during this study.

Stream	Date	Section (Aust. Map Grid)	Distance (km)	Prior Status of <i>L. spenceri</i>	Previous Searches	Spp. Recorded This Study
Thompson River	19/2/92	8122/342272 to 344272	0.2	extinct?	Watson et al. 1991	None
Thompson River	19/2/92	8122/289266 to 289269	0.3	unknown		<i>L. ewingii</i>
Matlock Creek	19/2/92	8122/297282 to 301281	0.5	unknown		None
Gordon River	20/2/92	8122/346339 to 355340	1.2	unknown	Watson et al. 1991	None
Gordon River	20/2/92	8122/378320 to 379328	1.4		Watson et al. 1991	<i>L. lesueuri</i> <i>G. victoriana</i>
Aberfeldy River	21/2/92	8122/459297 to 462289	1.2	unknown	Watson et al. 1991	<i>L. ewingii</i> <i>L. lesueuri</i>
Goulburn River	21/2/92	8122/336418 to 337417	0.2	extinct?	Watson et al. 1991	None
Goulburn River	21/2/92 -22/2/92	8122/384479 to 386470	1.5	unknown		<i>L. spenceri</i> <i>L. lesueuri</i>
Goulburn River	23/2/92	8122/379463 to 380464	0.1	unknown		<i>L. spenceri</i>
Goulburn River	24/2/92	8123/335540 to 337540	0.2	unknown		<i>L. spenceri</i>
Black River	23/2/92	8122/385478 to 398468	2.0	unknown		<i>L. spenceri</i> <i>L. lesueuri</i>
Taponga River	25/2/92 -26/2/92	8123/152621 to 165637	1.7	extant	Watson et al. 1991 Hero & Robertson unpubl. data	<i>L. spenceri</i> <i>L. lesueuri</i> <i>G. victoriana</i> <i>R. signifera</i>
Still Creek	25/2/92 -26/2/92	8123/146625 to 158626	1.2	extant	Watson et al. 1991 Hero & Robertson unpubl. data	<i>L. spenceri</i> <i>L. lesueuri</i> <i>G. vitoriana</i>
Big River (Eildon)	25/2/92 -26/2/92	8123/163639 to 164634	0.5	extinct?	Watson et al. 1991	None
Big River (Eildon)	26/2/92	8123/201579 to 204573	0.9	unknown	Watson et al. 1991	<i>L. spenceri</i>
Big River (Eildon)	26/2/92	8123/198509	0.08	unknown		<i>L. spenceri</i> <i>L. lesueuri</i>
Howqua River	26/2/92 -27/2/92	8223/595863 to 604857	1.5	extinct?	Hero 1990 Watson et al. 1991	None
King River	27/2/92	8223/617952 to 620948	0.5	extinct?	Hero 1990 Watson et al. 1991	None
Big River (Mitta Mitta)	30/1/92 5/3/92 -10/3/92	8324/338293 to 346276	3.2	unknown		<i>L. spenceri</i>
Big River (Mitta Mitta)	6/3/92 -8/3/92	8324/389248 to 390224	3.5	unknown		<i>L. spenceri</i> <i>L. verreauxi</i> <i>alpina</i>
Big River (Mitta Mitta)	8/3/92 -9/3/92	8324/396216 to 400210	0.7	extinct?	Hero 1990 Watson et al. 1991	<i>L. spenceri</i> <i>L. lesueuri</i>

Table 1 continued

Stream	Date	Section (Aust. Map Grid)	Distance (km)	Prior Status of <i>L. spenceri</i>	Previous Searches	Spp. Recorded This Study
Wild Horse Creek	30/1/92 7/3/93	8324/376231 to 385230		unknown		None
Lightning Creek	11/3/92	8324/396403 to 399402	0.6	extinct?	Hero 1990 Watson et al. 1991	<i>L. spenceri</i> <i>L. lesueuri</i>
Lightning Creek	11/3/92	8324/426385 to 429388	1.0	unknown		<i>L. lesueuri</i>
Lightning Creek	11/3/92	8324/428382 to 430382	0.4	unknown		None
Snowy Creek	12/3/92	8324/374411 to 380420	1.7	unknown	Watson et al. 1991	<i>L. spenceri</i> <i>L. lesueuri</i>
Snowy Creek	12/3/92 26/3/92	8324/375390 to 378397	2.8	unknown		<i>L. spenceri</i>
Snowy Creek	12/3/92	8324/378424	0.05	unknown	Watson et al. 1991	<i>L. spenceri</i> <i>L. lesueuri</i>
Mount Wills Creek	12/3/92	8324/393372 to 398373	0.3	unknown		None
Mount Wills Creek	12/3/92	8324/393375 to 395376	0.3	unknown		None

Table 2. Number of animals located, population structure and kilometres searched in each stream along which Spotted Tree Frogs were recorded.

* = Juvenile frogs and tadpoles.

	Goulburn and Black R.	Taponga R. and Still Ck	Big R. (Eildon)	Big R. (Mitta)	Lightning Ck.	Snowy Ck.	Total
No. Juveniles* (%)	102 (54.6)	15 (26.0)	2 (66.7)	25 (37.3)	12 (100)	58 (100)	214 (55.6)
No. Sub Adults (%)	49 (26.2)	20 (34.4)	1 (33.3)	39 (58.2)	-	-	109 (28.3)
No. Adult Males (%)	29 (15.5)	13 (22.4)	-	3 (4.5)	-	-	45 (11.7)
No. Adult Females (%)	7 (3.7)	10 (17.2)	-	-	-	-	17 (4.4)
Total	187	58	3	67	12	58	385
Distance							
Sampled(km)	4.0	2.9	1.5	7.4	2.0	4.6	
Total No./100m	4.7	2.0	0.2	0.9	0.6	1.4	

Table 3. Micro-habitats in which Spotted Tree Frogs were found. Numbers are given.

	Shingle bank	Loose rocks beside stream	Loose rocks in stream	Bed- rock	Vegetation on bank	In flowing stream	Connected streamside pool
Juveniles	155	16	6	21	5		
Sub-adults	27	56	23	3	-		
Adults	6	16	36	4	-		
Tadpoles						3	8
Total	188	-	88	65	28	5	8

records. Their occurrence varied from 26.2% of captures in the Goulburn/Black River to 58.2% in the Big River (Mitta Mitta). Adults were only recorded in three stream systems. Their occurrence varied from 39.6% of captures in the Taponga River/Still Creek population, to 4.5% in the Big River (Mitta Mitta). Adult females were only recorded in two of these systems, and were less abundant than adult males. In all, only two stream systems, the Goulburn/Black River and the Taponga River/Still Creek, supported significant proportions of all three age-classes.

Habitat preferences

Spotted Tree Frogs were found in various micro-habitats along the streams surveyed. These micro-habitats have been broadly classified into categories (Table 3). Spotted Tree Frogs were only located in the immediate stream environment; however, this may largely reflect sampling bias. All individuals were associated with rocks, with the exception of five juveniles found perched on sedges (*Carex* sp.) along shingle banks. No individuals were found in association with fallen timber or earthen banks. The vast majority of juveniles were recorded along the edges of shingle banks. Most sub-adults were located amongst rocks, adjacent to the stream. The majority of adults was located in crevices between rocks surrounded by water in rapid sections. About 20% of sub-adults, most of which were of adult size, were also found in this situation. Exposed sections of bed-rock of streams were utilized by all age-classes, but did not appear to be the preferred substrate. However, this may reflect the relatively limited extent of this substrate along the streams surveyed.

Activity

Frogs were found either perched on or sheltering under rocks and shingles, or in crevices between loose rocks. Individuals of all age-classes were observed basking throughout the day during periods of high insolation. Basking adults and sub-adults were typically found perched on rocks adjacent to swift sections of stream, into

which they jumped when disturbed. One male was heard calling briefly at dusk along the Goulburn River on 21st February 1992. One female was found perched on a shingle bank in this stream at night.

Habitat Disturbance

Obvious disturbance was observed along a number of streams where Spotted Tree Frogs were found. An eductor dredge was being operated along the Goulburn River near the Black River at the time of survey. Four or five old dredge sites were observed along a 2km stretch of the Goulburn River up stream from this confluence. These sites had apparently been operated earlier that summer (Dredge Operator pers. comm.). Old dredge sites were also observed along stretches of Lightning Creek and Big River (Eildon). Major disturbances at these sites were log dams along the river, removal and mounding of river bed alluvium, partial clearance of vegetation and litter, including plastic sheeting and empty fuel drums.

Disturbance of the Black River was observed from recent road works along Webber Spur Track. The road has been upgraded, and follows a side-cut close to the eastern side of the river for 100-200m. A substantial amount of rock and sediment had been displaced into the stream, both at the river crossing and upstream adjacent to the cutting.

Blackberries (*Rubus* sp.) were observed along all water-courses. Infestations were scarce along the Black River, the Goulburn River and the upper reaches of the Big River (Mitta Mitta). Infestations were most severe along Snowy and Lightning Creeks. Willows (*Salix* sp.) and other weed species were also recorded along lower stretches of Snowy Creek (Johnson 1992).

Lightning Creek and lower Snowy Creek appear to be the most disturbed streams in which Spotted Tree Frogs were found. In addition to weed infestations, there are 13 track-crossings on Lightning Creek and evidence of extensive eductor dredging up stream. Snowy Creek flows next to the Omeo Highway down stream from Lightning Creek and is disturbed by rubble from road construction and road run off.

Other disturbances identified in this area include recreational four-wheel-driving, camping, fishing and cattle grazing.

Discussion

The Spotted Tree Frog is known to still exist on only one other stream not examined during this survey, the Wongungarra River (Hero 1990; Watson *et al.* 1991). In all, the species is now known to occur on nine streams. If it is assumed that the individuals from Lightning and Snowy Creek are not of the same population, seven different populations can be identified from surveys. Of these, the population on the Goulburn/Black River is the largest, and the populations on the Wongungarra River and Lightning Creek are likely to be the smallest and most restricted. Repeated searches carried out by Watson *et al.* (1991), staff from DCE, North East Region (G. Johnson pers. comm., DCE Wodonga, Victoria) and during this study suggest that the species is extinct on the Thompson, Howqua, King and Buckland Rivers and Buffalo Creek, and has disappeared from parts of its original distribution on the Goulburn River and the Big River (Eildon).

Frogs in the juvenile age-class located during this survey are within the size range of juveniles collected on the Taponga River in February 1991 (Hero and Robertson unpubl. data). The presence of juveniles indicates that breeding occurred during the 1991/1992 season in all streams in which Spotted Tree Frogs were located. The sizes of individuals in the sub-adult age class are consistent with the expected growth rate of juveniles from the previous season. The occurrence of sub-adults therefore suggests that successful breeding also took place in the 1990/1991 season in the Taponga River/Still Creek, the Goulburn/Black River, and the populations in both Big Rivers. Furthermore, data previously collected from the population on the Taponga River indicate that reproduction also occurred successfully there in the 1989/1990 season (Hero and Robertson unpubl. data), suggesting a degree of stability within this population. Although

the relative percentages differ, the populations on the Taponga River/Still Creek and the Goulburn/Black River both contain significant proportions of adults and sub-adults; reflecting a similar stability in their recent history.

Different age-classes appear either to favour, or are more easily detected in, different micro-habitats. Therefore, differences in the extent of various micro-habitats between stream systems may contribute to the variation in the proportions of age-classes detected between populations. However, this is unlikely to explain the marked variation apparent in the proportions of certain age-classes between some stream systems.

Failure to detect any adults in Snowy and Lightning Creeks indicates that the resident adult population is very small by comparison to that in the Taponga and the Goulburn/Black Rivers. Abundance and distribution of juveniles along Snowy Creek suggests that reproduction may have occurred at a number of widely spaced locations or, alternatively, that offspring of a small number of adults up stream have subsequently been washed or travelled down stream to several localities.

Seasonal factors may have also contributed to the marked variation in abundance of adults between these streams. The Goulburn, Black and Taponga Rivers were sampled in late February, while Snowy Creek and Lightning Creek were sampled one to three weeks later in March. Adults and sub-adults may move away from the streams at this time of the year, thus reducing their detectability. However, this possibility fails to explain the number of historical records from March and April (Watson *et al.* 1991), or the abundance of sub-adults recorded along the Big River (Mitta Mitta), which was also surveyed in March. The population on the Big River (Mitta Mitta) appears to have successfully reproduced in the past two seasons, but the low proportion of adults suggests that, as with Snowy Creek and Lightning Creek, the resident adult population is very small in

comparison to those in the Taponga and Goulburn River systems.

No individuals were recorded in Snowy Creek and Lightning Creek and the Big River (Mitta Mitta) during summer-autumn periods in 1989 and 1990 (Watson *et al.* 1991), although searches on the Big River during those seasons were restricted to the presently known lower limit of the distribution of the Spotted Tree Frog. This result suggests that reproduction was substantially less successful in those seasons, and that adults, if present, were also in very low numbers. The absence of sub-adults in Snowy and Lightning Creeks during the present study may be explained if reproduction was also substantially less successful in the 1990/1991 season. Alternatively, viability of juveniles may be comparatively low in these two streams and only a few individuals may have survived from the 1990/1991 season. This factor may have contributed to a low adult recruitment rate in these streams.

The number and distribution of juveniles located on Lightning Creek suggests only one reproductive event may have occurred on this stream in 1991/1992, or, alternatively, juvenile viability is very low. Given that the location is very close to the original site at which Spotted Tree Frogs were last seen in 1983, it is conceivable that a small population has remained on the stream undetected, possibly due to poor breeding seasons. However, given the proximity to Snowy Creek (approximately 4km), some individuals may have recently colonized the area from down-stream.

The distribution and abundance of juveniles alone provides only limited information at this stage on the size of the adult population, distribution and habitat preferences. Clutch size and juvenile mortality are unknown. Mortality of tadpoles and juveniles may vary considerably between streams and different habitats, depending on environmental conditions and levels of disturbance. The mobility of the tadpoles in swift streams over the period of their development is also unknown. It is possible that tadpoles in the main stream disperse considerable

distances from breeding sites. Juveniles may emerge substantial distances downstream from optimal stream habitat. Caution should therefore be applied when interpreting the presence or absence of juveniles in certain stream habitats. For instance, juveniles recorded on lower stretches of Snowy Creek in comparatively disturbed areas could have been washed down stream from less disturbed sites, and their viability in these disturbed areas may be substantially reduced.

Future Directions

The discovery of new populations of Spotted Tree Frogs in previously unsurveyed areas highlights the need for further surveys of remote and relatively less disturbed catchments in the Central Highlands and north-east Victoria. A number of major catchments has not been properly investigated yet. The following list is a selection of streams within the broad distribution of the Spotted Tree Frog which have forested catchments, relatively little road-access, and are either poorly or previously unsurveyed:

Mount Skene Ck.	Wonnangatta R.
Jamieson R.	Moroka R.
Barkley R.	Dandongadale R.
Macallister R.	Buffalo R.
Caledonia R.	Yarrarabula R.
Catherine R.	Bundara R.
Humphrey R.	Wombat Ck.
Snowy Ck.	West Br.

A more thorough scrutiny of the Central Highlands and north-east regions of Victoria, incorporating historical data on various disturbance regimes and land management practices, should provide a list of priority areas for future investigation.

Further surveying of the Big River (Eildon), Goulburn River, Black River and Snowy Creek is also required to establish the extent of the distribution of Spotted Tree Frogs and breeding habitats along these water courses.

The rediscovery of the Spotted Tree Frog along several streams may indicate a recovery of some populations from some stochastic disturbance, or that there have

been unusually good breeding seasons for a number of very small populations. More information is required on these populations before their status and distribution can be assessed. Monitoring in late spring and late summer of 1992/1993 should provide information on survival of juveniles, adult recruitment, on-going reproductive success, and distribution of adults.

Monitoring of the population on the Taponga River/Still Creek should be intensified over the 1992/1993 season, with the aim of characterising breeding biology and other activity patterns of the species. The Taponga River system is suitable for this purpose because of easy access and the knowledge of recent history of the population.

The abundance and distribution of the Spotted Tree Frog on the Wongungarra River needs assessment in view of possible increases in other populations. On-going monitoring and characterisation of this population is important since it is by far the least disturbed, and is the only population suitable for a control in any future assessments of man-made disturbances on the species.

A review of sampling techniques and development of more detailed research objectives is required prior to further field work. This should involve expertise from the Department of Zoology, University of Melbourne, and Fauna Branch, Department of Conservation and Environment.

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The Mammals of the Bamganie State Forest, Victoria

L.E. Conole* and G.A. Baverstock**

Introduction

The authors have been conducting mammal surveys throughout the greater Geelong-Otway district since 1978 in an attempt to provide basic inventory information on mammals for all public land in that area. These surveys, motivated solely by the authors' personal interest in contributing to knowledge on the subject, are conducted on a voluntary basis, and the constraints of time and fiscal resources largely dictate the survey methodologies adopted. As part of this ongoing project, the authors surveyed mammals at the Bamganie State Forest (38°53' S 144°00' E) between 1987 and 1991. The Bamganie survey was also related to investigations being conducted at other western plains native vegetation remnants at Bannockburn (Baverstock and Conole 1991), Inverleigh Common Flora Reserve (Conole & Baverstock 1982, 1983, 1985, in press) and Teesdale Woodlot (Conole & Baverstock unpubl. data). The results of the mammal survey are presented here as a catalogue of species occurring in the Bamganie State Forest, and contribute to the basic data necessary to conserve the mammal fauna of the Geelong region.

The Bamganie State Forest is *circa* 600 hectares of Uncommitted Crown Land (LCC 1985) located about 45 kilometres north-west of Geelong on undulating uplands 280 to 340 metres above sea level to the north of the volcanic plains. The vegetation is classified by the LCC (1985) as Open Forest II, and is predominantly Messmate Stringybark (*Eucalyptus obliqua*) open-forest, with a narrow band of Swamp Gum (*E. ovata*) woodland and open-forest along the southern boundary. The major middle storey tree is Black Wattle (*Acacia mearnsii*) with an area of dense regrowth of Golden Wattle (*A. pycnantha*) and scattered stands of

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Lightwood (*A. implexa*). Along the deeply dissected gully of the Woodburne Creek occur Blackwood (*A. melanoxylon*) and Silver Wattle (*A. dealbata*). In Swamp Gum woodland, areas of closely grazed grasses occur, often referred to as 'kangaroo lawns'. Ground cover dominants occur in single species swards, and include Austral Bracken (*Pteridium esculentum*), Saw-sedge *Gahnia* sp., Spiny-headed Mat-rush (*Lomandra longifolia*) and tussock grasses (*Poa* sp.). Comparable areas of Open Forest II (*sensu* LCC 1985) on similar substrates in the nearby Brisbane Ranges National Park are more floristically diverse, and the authors maintain that the open-forest understorey at Bamganie has been depleted by the exploitative history documented in LCC (1985). Despite this history, a number of very old Messmate Stringybarks and a lesser number of older Swamp Gums provide roosts, dens and breeding sites for hollow dependant fauna. Bamganie State Forest is completely surrounded by farmland, and only has a skeletal corridor connection to other blocks along Woodburne Creek.

Survey Techniques

The apparent biases in distribution of survey effort between the techniques is an artefact of the determining factors of time and money availability acting on volunteers.

Mammals were surveyed by live trapping, spotlighting, chance observations and indirect signs. The trapping effort (see tables 1 and 2) consisted of cage traps set on the ground (252 trap nights), cage traps set in trees (40 trap nights), 'harp' bat traps (12 trap nights), trip-lines over water (2 trap

Table 1: Total Trapping Effort

Trapping Type	Trap Nights
Cage trap - ground set	252
Cage trap - tree set	40
Pitfall trap	24
"Harp" bat trap	12
Trip lines (dusk to midnight)	2

Table 2: Trapping Results

Species	Number Trapped (n)	n/Trap Night
<i>Trichosurus vulpecula</i>	8	0.03
<i>Pipistrellus darlingtoni</i>	27	2.3
<i>Pipistrellus regulus</i>	21	1.8
<i>Pipistrellus vulturinus</i>	80	6.7
<i>Chalinolobus gouldii</i>	9	0.8
<i>Chalinolobus morio</i>	17	1.4
<i>Nyctophilus geoffroyi</i>	67	5.6
<i>Rattus rattus</i>	41	0.2

Trip-lining data has been excluded from the analysis for bats as it is incompatible with the greater body of 'harp' trap data.

nights) and pitfall traps (24 trap nights). The spotlighting effort (see table 3) was 12 hours, and was conducted with 2 x 30 Watt hand-held spotlights on a walking survey. Indirect methods included the recognition of vocalisations, tracks, scats, foraging signs and skeletal material.

Table 3: Spotlighting Results

Species	Total Individuals	Mean Spotlighting Rate/Hour
<i>Tachyglossus aculeatus</i>	1	0.1
<i>Phascogale tapoatafa</i>	3	0.2
<i>Trichosurus vulpecula</i>	38	3.3
<i>Pseudocheirus peregrinus</i>	156	13.9
<i>Petaurus breviceps</i>	6	0.6
<i>Phascalarctos cinereus</i>	27	2.2
<i>Macropus giganteus</i>	21	2.1
<i>Wallabia bicolor</i>	2	0.2
<i>Oryctolagus cuniculus</i>	16	1.4
<i>Vulpes vulpes</i>	1	0.1
TOTAL	271	22.6

Total spotlighting time = 12 hours

Results and Discussions

1. *Tachyglossus aculeatus* Short-beaked Echidna. Although seldom observed directly, the distinctive foraging signs of *T. aculeatus* are found widely and abundantly throughout the forest. We have no systematic measure of its abundance, other than that it comprised only 0.4% of mammals detected during spotlight survey.

2. *Phascogale tapoatafa* Brush-tailed Phascogale. Three specimens of *P. tapoatafa* were observed during spotlight surveys (mean spotlighting rate [MSR] of 0.2/hr., 1.1% of mammals detected during spotlight survey [MDDSS]), and appears widely distributed through the forest. In the wider Geelong area, *P. tapoatafa* is extant at Staughton Vale, Anakie Gorge and Durdidwarrah in the Brisbane Ranges (Conole and Baverstock 1988, G. McCarthy and T. Pescott pers. comm.), on the Barwon River at Ceres (T. Pescott pers. comm.) and in the Lal Lal area (Conole and Baverstock unpubl. data). It previously occurred widely on the Bellarine Peninsula around Ocean Grove through to Queenscliff (J. Wheeler and T. Pescott pers. comm.), but appears to be locally extinct there now. *P. tapoatafa* is poorly represented in public land reserves, in the Geelong region only recorded from the Brisbane Ranges National Park (Conole and Baverstock pers. obs.), and its presence at Bamganie State Forest may be important for the local conservation of the species.

3. *Trichosurus vulpecula* Common Brushtail Possum. *T. vulpecula* was commonly spotlighted (MSR = 3.3/hr, MDDSS = 14.0%) and trapped on the ground (0.03/trap night). Although widely distributed, the species appears to be most abundant in the more open habitats on the forest perimeter.

4. *Pseudocheirus peregrinus* Common Ringtail Possum. *P. peregrinus* was the most frequently observed species in spotlight surveys (MSR = 13.9/hr, MDDSS = 57.5%). The species occurs throughout the forest, and appears to be the most abundant arboreal marsupial. *P. peregrinus* is a major prey item of the Powerful Owl (*Ninox strenua*), as determined from the examination of cast pellets found under an owl roost. In Swamp Gum woodland, a Powerful Owl was observed carrying a dead *P. peregrinus*.

5. *Petaurus breviceps* Sugar Glider. Detected by direct spotlight observation (MSR = 0.6/hr, MDDSS = 2.2%) in addition to recognition of its vocalisations. A *P. breviceps* den was found in a Swamp Gum, from which 10-12 individuals were observed leaving on dusk, 29 January, 1989.
6. *Acrobates pygmaeus* Feathertail Glider. Only observed in Swamp Gum open-forest, where 5-6 individuals were seen in one flowering Swamp Gum on 29 January, 1989. The authors suggest that the apparent absence of *A. pygmaeus* from the Messmate Stringybark open-forest is more likely due to the larger leaves and denser canopy obscuring the diminutive mammal. Swamp Gums with their small leaves and open crown permit better visibility.
7. *Phascolarctos cinereus* Koala. Widely distributed through the forest and surrounding farmland district; apparently abundant in the forest (MSR = 2.2/hr, MDDSS = 10%). Skeletal material of *P. cinereus* is abundant throughout Bamganie.
8. *Macropus giganteus* Eastern Grey Kangaroo. A mob of 8-10 *M. giganteus* was often observed on farmland adjacent to the southern entrance to Bamganie on Deans Road, and on the south-west corner. Relative abundance from spotlight survey: MSR = 2.1, MDDSS = 7.7%.
9. *Wallabia bicolor* Swamp Wallaby. Observed throughout Bamganie State Forest during spotlight survey (MSR = 0.2/hr, MDDSS = 0.7%) and numerous chance sightings during the day.
10. *Nyctinomus australis* White-striped Mastiff-bat. Detected throughout the forest by recognition of its characteristic, low frequency, echolocatory vocalisations, but not directly observed. Widely distributed but of unknown abundance.
11. *Pipistrellus darlingtoni* Large Forest Pipistrelle.
12. *Pipistrellus regulus* King River Pipistrelle.
13. *Pipistrellus vulturinus* Little Forest Pipistrelle.

NB: These bats were previously regarded as *Eptesicus* species, but have been included in *Pipistrellus* as an endemic Australian subgenus *Vespadelus* (Hill and Harrison 1987). All three species of *Pipistrellus* were widely recorded at Bamganie, and appear to be abundant. The relative abundances from trapping suggest that *P. vulturinus* is most abundant (6.7/trap night), followed by *P. darlingtoni* (2.3/trap night) and *P. regulus* (1.8/trap night).

14. *Chalinolobus gouldii* Gould's Wattled Bat.
15. *Chalinolobus morio* Chocolate Wattled Bat.

Both species of *Chalinolobus* occur widely in the forest, although relatively less abundant than either *Pipistrellus* species or *Nyctophilus geoffroyi* (*C. gouldii*: 0.8/trap night, *C. morio*: 1.4/trap night). The authors' field experience has been that whilst *C. morio* is more easily captured in 'harp' traps than by trip-lines, the reverse is true for *C. gouldii*. This difference is attributable to differing wing shape and size affecting the wing loading in the two species (Conole unpubl. data). The sparing use of the trip-lining method at Bamganie has probably distorted the relative abundance of *C. gouldii* with respect to *C. morio*. *C. gouldii* was commonly seen in flight around dusk at Bamganie.

16. *Nyctophilus geoffroyi* Lesser Long-eared Bat. Widely encountered and apparently abundant (5.6/trap night) at Bamganie State Forest. High capture rates for *N. geoffroyi* in areas of dense Golden Wattle regrowth reflect its tendency to fly through thick vegetation (Conole pers. obs.). Bat traps partly covered by vegetation often trap larger numbers of *Nyctophilus* species than traps set in the open (Conole and Baverstock pers. obs.).

Suitable habitat for Gould's Long-eared Bat *Nyctophilus gouldi* (Lunney et al. 1988) occurs in the Woodburne Creek gully, and the species may occur at Bamganie.

17. *Rattus rattus* Black Rat. A very abundant introduced species. A number of *R. rattus* were trapped on the ground (0.1/trap night) but none in trees, despite its known arboreal habit (Strahan 1983, Conole pers. obs.). Many items of rubbish such as derelict car bodies had numbers of rats living in them. The survey detected no small, terrestrial, native mammals such as the expected Brown Antechinus (*Antechinus stuartii*) and Bush Rat (*R. fuscipes*), and it is possible that *R. rattus* has proliferated in these vacant niches.

18. *Mus musculus* House Mouse. No *M. musculus* were trapped, and only one was observed during log rolling and metal lifting efforts. It seems to be locally rare, but we have no measure of its abundance.

19. *Oryctolagus cuniculus* European Rabbit.

20. *Lepus capensis* Brown Hare.

Both species occur throughout the Swamp Gum area, and *O. cuniculus* is abundant there. Both species are apparently less abundant in the Messmate Stringybark area.

21. *Vulpes vulpes* Fox. Widely distributed introduced predator. Despite high densities of *R. rattus* and *O. cuniculus*, few *V. vulpes* were observed.

22. *Felis catus* Cat. This species was detected only once, and then only indirectly from footprints in damp sand on a track near farmland.

The species of mammals recorded at the Bamganie State Forest (600 hectares) are essentially the same as at the other remnants nearby. At the 'Bannockburn Bush' (360 hectares) 22 species were recorded (Baverstock and Conole 1991), and at the Inverleigh Common Flora Reserve (1050 hectares) 23 species. The major differences between them are that

the Great Pipistrelle (*Pipistrellus (Falsistrellus) tasmaniensis*) has been recorded as a breeding, rare resident, and the Little Red Flying-fox (*Pteropus scapulatus*) as a vagrant at the Inverleigh Common (Conole and Baverstock 1985), but not at the other two blocks. The Brush-tailed Phascogale (*Phascogale tapoatafa*) has only been recorded at Bamganie (Conole and Baverstock this paper), and the Common Dunnart (*Sminthopsis murina*) has only been recorded at Bannockburn but may now be extinct there (Baverstock and Conole 1991). The Yellow-bellied Sheathtail-bat (*Saccopteryx flaviventris*) has been recorded around Bannockburn and Inverleigh Common (Baverstock and Conole 1991, Conole and Baverstock 1985), but as a high flying aerial insectivore could be expected to occur anywhere in the area. Across the three blocks, the mammal fauna comprises 21-27% introduced species. Another unifying trend is the apparent absence of small, terrestrial, native mammals in the three blocks.

The Common Ringtail Possum (*Pseudocheirus peregrinus*), abundant at Bamganie State Forest, is uncommon at Bannockburn (Conole and Baverstock pers. obs.) and possibly on the verge of extinction at Inverleigh Common (Conole and Baverstock in prep.). The authors believe that the decline of *P. peregrinus* at Inverleigh may be attributable to a history of indiscriminate wood collecting which has substantially altered the structure of the habitat and removed some of the sub-canopy structure (Conole and Baverstock in prep.). The pressure on the Inverleigh Common Flora Reserve for wood collection was alleviated for some time by the opening up of some Sugar Gum (*Eucalyptus cladocalyx*) plantations there for firewood. The plantations have been extensively cut over, and Bamganie State Forest has been nominated to take the wood collecting pressure in the future. This operation at Bamganie will have to be carefully planned and monitored or the risk may be the endangerment of some of Bamganie's hollow dependant fauna such

as *Phascogale tapoatafa*, the Powerful Owl (*Ninox strenua*), and others.

The authors see the importance of the work reported in this paper in part as providing the only baseline data on the mammal fauna of the Bamgamie State Forest prior to the Department of Conservation and Environment turning the area over to a higher level of exploitation which may be an endangering process. The conservation of mammal fauna in these isolates west and north-west of Geelong would be enhanced by priority being given to conservation values in management and a co-ordinated management plan for the three blocks.

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Book Review

Australia's National Parks — Images and Impressions

by Jocelyn Burt

Publishers: *Houghton Mifflin Company (1991)*

Price (hard cover) \$40.

This beautifully presented book of 128 pages covers more than 60 National Parks from all States and the Northern Territory. The selected parks, mostly accessible in conventional two-wheeled drive vehicles, are grouped in States/Territory and range in number from 5 in Tasmania to 10 in each of Queensland, New South Wales and Victoria.

The book does not purport to be a detailed guide to all aspects of the parks, but neither is it just a picture book, even though the quite magnificent photographs contribute greatly to its charm and appeal. The photographs are directed predominantly at the scenic aspects- beautiful landscapes, spectacular rocky outcrops or other striking topographical features. However, naturalists may be disappointed that there are relatively few pictures of specific fauna or flora.

The text, generally only a few paragraphs about each park and written in a delightfully conversational style, elaborates on specific features and/or relates personal anecdotes and impressions and/or provides useful information for travellers.

Overall it is an excellent book which will provide much pleasure and interest to a wide range of readers. It will generate fond memories for those who have visited particular parks and will certainly stimulate those who have not to try and do so.

Arthur Farnworth

An Additional Historical Record of Leadbeater's Possum, *Gymnobelideus leadbeateri* McCoy, prior to the 1961 Re-discovery of the Species.

D.B. Lindenmayer* and J.M. Dixon**

The endangered species of arboreal marsupial, Leadbeater's possum, *Gymnobelideus leadbeateri* McCoy, is significant because it is the only native mammal restricted to Victoria and one of the faunal emblems of that State. Virtually all sightings of *G. leadbeateri* in the past 30 years are from the Central Highlands of Victoria within an area of 60 km x 50 km that has limits of approximately 37°20' and 37°55'S latitude and 145°30' and 146°20'E longitude (Lindenmayer *et al.* 1991a). Some of the more major settlements in this region include Healesville, Marysville, Warburton, Poweltown, Noojee and Tanjil Bren.

All the records of *G. leadbeateri* dating from before its re-discovery in 1961, including those from where the species was described, were collected outside the Central Highlands of Victoria (Lindenmayer *et al.* 1991a). This note summarises the early distribution records of *G. leadbeateri* and describes a specimen previously overlooked before the re-discovery of the species in 1961.

G. leadbeateri was described from two male specimens (No. C4379 and C4380) collected from the banks of the Bass River near Westernport, south-eastern Victoria (McCoy 1867; Dixon 1970). Kemp (1979) considered that these animals may have come from Woodleigh Station, north-east of Korumburra. However, the precise location of these specimens has not been resolved.

In the 40 years following the discovery of the species, only two additional specimens were taken (No. C1965 and C4378). Initially, both were believed to have

been collected in 1899 from the Bass River area (Anon 1899) approximately 60 km to the south of the Central Highlands of Victoria. Professor B. Spencer reported that one of these specimens, a male (No C1965) and the third to be collected, was presented to the National Museum of Victoria by Mr. A. Coles (Anon 1899). However, Brazenor (1932) discovered that one of the animals (No. C4378) was collected from Koo Wee Rup Swamp, 30 km to the north of the Bass River. Brazenor (1932) also found a previously overlooked female specimen (No. 4377) from an abandoned gold mining camp at Sunnyside, Mt. Wills in north-central Victoria, approximately 250 km north-east of the locations of the other records of the species. Repeated surveys in the Sunnyside area (Brazenor 1932, Fleay 1933) and the nearby Mitta Mitta area (Brazenor 1931), failed to locate *G. leadbeateri*. Surveys in the Bass River Valley and Koo Wee Rup regions were also unsuccessful (Nicholls 1911; Barrett 1942) and by the mid-20th century the species was considered to be extinct (Brazenor 1950). *G. leadbeateri* was "re-discovered" in 1961 near Marysville, in the Central Highlands of Victoria (Wilkinson 1961). The species had not been known from this region before this time.

Prior to 1961, five specimens of *G. leadbeateri* were collected, and all of these dated from 1909 or earlier. A recent examination of records in the National Museum of Victoria has revealed the existence of another record of the species dating from before 1961. A mounted specimen of *G. leadbeateri* (No. C3148) is presently held in the National Museum of Victoria. The specimen was originally housed in the Burke Museum in Beechworth, northern Victoria. The present administrator of the Burke Museum, Mr. G. Gray, personally delivered

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the specimen for cleaning to the National Museum of Victoria in the early 1960s (G. Gray pers.comm.). The existence of the mounted specimen of *G. leadbeateri* in the natural history collection was acknowledged in the Report of the Burke Memorial Museum, dated 16 December 1960. The specimen was contained in a cabinet with numerous other mounted study skins and was between 50-100 years old at the time of its transport to Melbourne in the early 1960's (G. Gray pers. comm.). A check of the Natural History Catalogue at the Burke Museum (1877-1933) as well as the records of the Museum of Victoria has revealed no other details of the specimen and the exact site of collection could not be determined. Further evidence of the existence of the specimen was confirmed by Dixon and Huxley (1981), and by an examination of records kept by the former Fisheries & Wildlife Division of Victoria (Department of Conservation & Environment, unpublished records).

During the mid-late 19th century, Beechworth was one of the major towns between Sydney and Melbourne and an exchange of specimens may have taken place between Beechworth and other centres. However, the town of Beechworth is only 90 km NW of Mt. Wills where *G. leadbeateri* was collected in 1909 (Brazenor 1932). It is possible that the mounted specimen from the Burke Museum, and now in the National Museum of Victoria, may be another record of *G. leadbeateri* from outside the Central Highlands of Victoria. The only other records of *G. leadbeateri* from areas north of the Central Highlands of Victoria are fossils from pleistocene-aged deposits in the Wombeyan and Marble Arch Caves in N.S.W. (Broom 1896, Hall 1974) and a number of similar deposits in the Buchan region (Hope 1976).

Acknowledgements

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Freshwater Algae: A Glimpse Underwater

by Timothy J. Entwistle*

*The focus for this article is the Yarra River basin, and the macroalgae fare better than the microalgae due to my own biases. Parts of this paper are taken from an article I published in *Tirra Lirra* (1991, no. 3, pp. 17-20) called 'Under the Surface'.*

Beneath the surface of any river, lake, pond or puddle, there are plants - some with flowers, some without. The flower-less plants, or 'cryptogams', include mosses, liverworts, fungi, lichens, and a fascinating group of primitive organisms - the algae. Simple in construction, algae can range from solitary swimming cells to large mats caked onto submerged rocks. As categories of convenience, the small ones are called 'microalgae' and the larger ones 'macroalgae'. The microalgae are invisible to the naked eye unless millions of them gather into what is termed a 'bloom' (with potentially disastrous results, as explained later). Free-floating microalgae are usually termed 'phytoplankton'. Macroalgae can be tufty, stringy or balloony, and are readily observed when water levels are low, particularly in summer and autumn.

The major taxonomic groups of algae - overlapping the micro and macro-categories - are named on the basis of their pervading colour. Thus, we talk of green, yellow-green, yellow-brown, brown, red and blue-green algae, depending on which, if any, pigments overwhelm the ever-present green chlorophyll. The system is hardly fool-proof, and other pigments may mask the 'characteristic' pigment of the taxonomic group; red algae in the Yarra River, for example, are generally brown, olive-green, or somewhat purplish.

As part of our native flora, the freshwater algae have been sadly neglected. Ugly as many appear in real life, they are transformed under the microscope (Fig. 1a-f). The sense of wonder and discovery experienced by today's phycologists is comparable to that of flowering-plant

specialists last century and we are still discovering the variety and extent of our freshwater algal flora. Interest in the freshwater algae of Australia began last century, pioneered in Victoria by an early member of the Field Naturalist Club of Victoria.

The Field Naturalist Club of Victoria

As librarian, committee member and vice-president, Henry Watts (1828-1889) was an enthusiastic member of the FNCV in the 1880s (Entwistle 1990a; see this reference for any further information on the history of freshwater algae in Victoria). He was also the first Australian to specialise in freshwater algae, publishing check-lists and excursion reports in *The Victorian Naturalist*. While many of his identifications are a little dubious, he was indisputably a pioneer in the microscopic study of algae in Australia. Soon after Watts, the Stickland family developed a keen interest in freshwater animals, also publishing a smattering of incidental records of algae in *The Victorian Naturalist* between 1895 and 1929.

Alfred D. Hardy (1870-1958), however, took the 'torch' from Watts and from 1904-1943 published a series of papers on freshwater algae. Hardy was a naturalist of catholic taste, his interests extending from trees to microalgae. As with Watts, Hardy worked in isolation. Certainly both were helped by herbarium and university staff, and had willing company on some of their collecting forages, but they did not attract any lasting band of enthusiastic collectors. However, they remain as two beacons of phycological activity in Victoria, but as I have observed elsewhere (Entwistle 1990a), the torch is once again alight.

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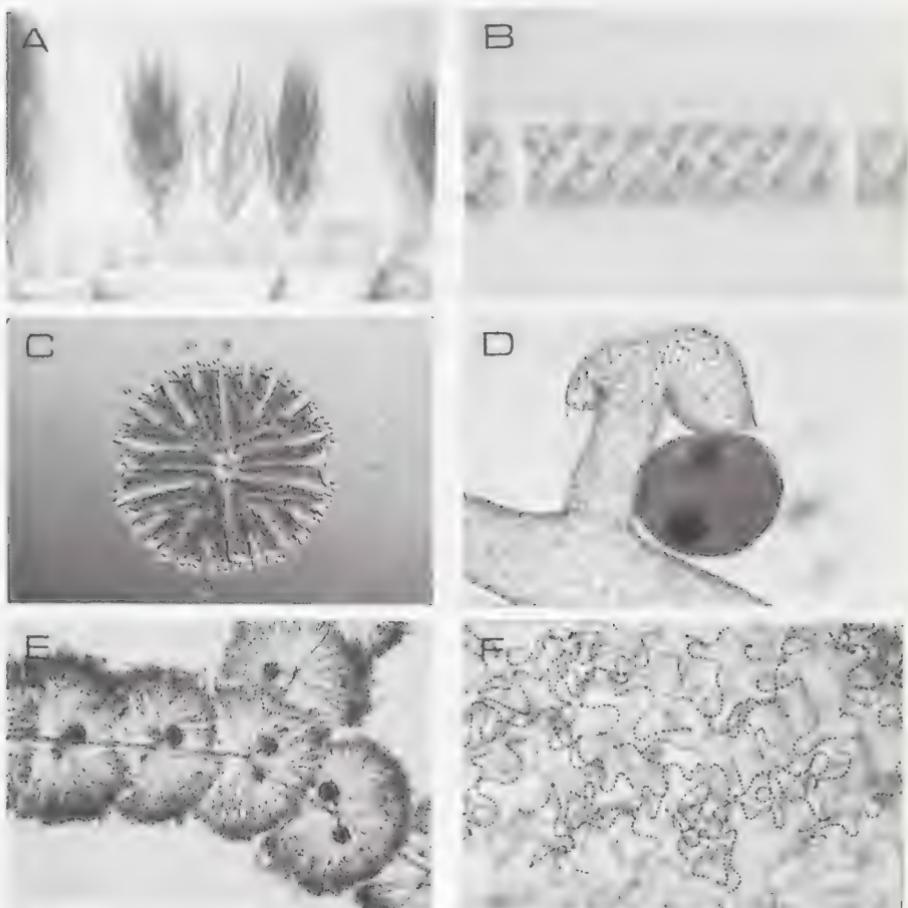


Fig. 1. Examples of freshwater algae. a, *Draparnaldia* (filamentous green alga) showing lateral brachlets, x 100. b, *Spirogyra* (filamentous green alga) showing spiralled chloroplast with prominent, spherical starch-forming bodies, x 200. c, *Micrasterias* (single-celled green alga; desmid) showing exquisite symmetry, x 200 [photograph kindly provided by Jeremy Pickett-Heaps, University of Melbourne]. d, *Vauchia* (yellow-green alga) showing vegetative siphon and large spore, x 100. e, *Batrachospermum* (red alga) showing whorls of lateral branchlets and spherical spore-bearing structures, x 40. f, *Nostoc* (blue-green alga/bacterium) showing arrangement of short filaments within gelatinous matrix, x 100.

In recent years, a small band of collectors seems to be emerging. In my own work I have focused on the macroalgae (e.g. Entwistle and Kraft 1984; Entwistle 1988; Entwistle 1989a) but elsewhere, particularly in Tasmania, the microalgae have received their due (see Tyler and Wickham 1988 for references).

Microalgae

The proliferation of reservoirs in

Australia has provided a whole new selection of habitats for phytoplankton. By slowing down rivers we have enhanced their suitability for microalgae. Even farm dams are a bonus to some inland algae, allowing them to spread across arid Australia (Tyler and Wickham 1988). While collecting has been most intense in the extremes of Australia - Arnhem Land and Tasmania - the homely habitats of Victoria

have not been forgotten (e.g. Chessman 1985a 1985b, 1986; Sullivan *et al.* 1988).

A key locality in Victoria is the Yan Yean Reservoir near the head of the Plenty River. It has been described as a 'classic site in Australian freshwater phycology' (Tyler and Wickham 1988; the following summary is taken from that publication).

Completed in 1857, the reservoir was Melbourne's first water supply, and in 1905-6 the site of the first taxonomic-ecological account of Australian freshwater algae. Alfred Hardy was the collector and G.S. West, in England, the taxonomist. In 1909, 104 species of microalgae were netted from the phytoplankton in Yan Yean reservoir.

Eighty-one (78%) of the species still inhabit the reservoir today. Those species not found in recent surveys were almost all rare in the time of Hardy and West. Most of these microalgae are desmids-symmetrical, single-celled green-algae, often with bizarrely ornamented processes (Fig. 1c). Two Australian endemics, *Micrasterias hardyi* G.S. West, named after the collector, and *Staurastrum victoriense* G.S. West, with its geographic epithet, are still to be found in Yan Yean Reservoir.

The reserved catchment with restricted public access has been a major factor in maintaining the high water quality and native microalgal diversity in the reservoir. Thankfully other reservoirs in the Yarra River catchment are similarly protected and preserve pristine streams suitable for macroalgal growth.

Macroalgae

River catchments in Australia which have received anything more than a cursory examination for macroalgae can be counted on one hand. Melbourne's backbone, the Yarra, happens to be one of the lucky ones (Entwistle 1989a, 1989b, 1990b). Even though more questions have been raised than answered, at least we have some idea of the diversity and workings of the Yarra River algal communities. That is good news for all who are interested in the health of our aquatic flora and fauna as

well as the health of the river itself which is a source of drinking water, recreation, and of course aesthetic beauty.

The Yarra and its tributaries are home to a large array of algae, some of which are not known outside Australia and others are restricted to one or two catchments within Victoria. The Yarra basin includes an intriguing gradient from pristine mountain streams to the sluggish upside-down river that inner city folk know so well.

Changes in the health of the river are reflected in the algal community. In the 1880s, an endemic species of red algae *Batrachospermum nodosum* (Skuja) Necchi & Entwistle was discovered in the Yarra River near Collingwood but over a hundred years later is known only upstream of Yarra Junction. Presumably it flourished along almost the entire length of the Yarra last century but has been forced upstream by rampant industrial and urban expansion. Around Warburton, olive-green tufts of this almost cartilaginous species appear in early summer and by autumn cover much of the rock surface. They share this habitat with another red alga, a member of the *Batrachospermum* genus, or Frog Spawns.

Microscopically these two red algae are quite similar with their prominent central thread encircled at regular nodes by radiating whorls of filaments (Fig. 1e). It is an intricate and exquisite design, only surpassed by the complexity of their reproductive cycle.

The life cycle of a red alga includes three distinct phases, (mosses and ferns have two distinct phases, while flowering plants and mammals have one), none of which is free-living (that is, each life phase is attached and dependent on another). A freshwater red alga starts as a tiny spore which germinates into a small cushion-like mound. Certain cells of this cushion essentially metamorphose into the conspicuous phase (Fig. 1e) - a bushy tuft some 5 to 10 cm long. Non-motile 'male' cells are produced in the whorls of filaments and become washed onto a 'female' receptor cell. Following sexual fusion, the egg develops into a small

parasitic third phase, which produces the tiny spores. Very intricate!

In spring, the rocks around Warburton are home to a range of green algae. They look much the same to the naked eye but do not fail to impress under the microscope: *Spirogyra* with its many spiralled chloroplasts; *Oedogonium* with its swollen egg cells, and *Parallela* a fragile sheet of glistening rows of grass-green cells. In winter or summer a whole new suite of algae colonize the rocks: greens; yellow-greens; blue-greens and perhaps an odd red as well.

If you head downstream to the polluted urban creeks of the inner suburbs the variety of algae diminishes and two green algae dominate most sites: *Stigeoclonium* (Fig. 1b) appears as bright green slippery tufts in winter and spring; *Cladophora* is duller, usually grey-green, and more like hair just after shampooing (and before conditioning!). *Cladophora* outcompetes *Stigeoclonium* in summer and autumn with its production of long (up to a few metres) clogging mats. If floods are not severe enough or the habitat particularly protected, it may even survive year round to the exclusion of its close relative.

At the top end of the Yarra catchment, in shaded mountain streams, a few red algae eke out an existence in the nutrient-poor waters and occasionally a blue-green or green appears, particularly in the broader reaches or beneath a clearing. Once again there are seasonal and annual oscillations.

On some small weirs in the Maroondah catchment the algae react dramatically to experimental timber harvesting. Weed species quickly dominate the weirs excluding the indigenous species for five years or more. If logging and associated practices (e.g. fertilising) are particularly severe, the native may never return. In any case, the weeds (whether they were originally Australian natives or immigrants is unknown) appear to retain their footing; but there are glimmers of hope, even in the urban creeks a small population of red algae-a species normally restricted to near

pristine mountain streams-persisted in the Darebin Creek near Parade College in Alphington until 1979 although it has not been seen since.

Toxic Algae

Some algae can poison reservoirs or, as we have discovered recently, large stretches of sluggish rivers. In the last three summers reservoirs and recreation lakes across the country have been closed while their toxic algae were poisoned or, where economics demanded, locals awaited a natural decline in algal numbers. Melbourne's water supplies, whose most rigorously protected catchments are on the Yarra River, have been immune from such problems. Nevertheless, toxic algae are set to become a hotter environmental issue every summer (see Working Party 1990 for some background information).

The main offenders are blue-green algae. These are mostly microscopic organisms with a cell organisation not unlike bacteria. They are now called the Cyanobacteria in deference to that similarity, but are quite distinct from the so-called photosynthetic bacteria. The blue-green algae, as they are still commonly called, occupy a diverse array of habitats, from antarctic lakes to desert sands. Almost all lakes and dams support some blue-green algal growth.

As with the formation of red tides in our coastal waters, blooms in lakes occur when the number of cells of a normally inconspicuous species increases to such an extent that the water becomes opaque and coloured (usually). Blue-green algae can produce a foul-smelling brew with the colour and texture of pea soup.

Algae have always caused problems for water managers. Although there is a diverse array of exquisite native species, certain algae produce unsightly slimes and scums in recreational lakes and rivers and can clog the filters and meters of water intake pipes. Massive proliferations of algae can lead to offensive tastes and odours in water, but more serious, are the select group of algae which are toxic to either humans, stock or native animal life.

In fresh or brackish water these toxic forms are mostly blue-green algae, although dinoflagellates and diatoms can form blooms in inland waters as well as in the sea. In humans they can cause eye and skin irritations (sometimes severe dermatitis), gastroenteritis (particularly in children), respiratory stress and liver damage and possible cancer links are currently under investigation. Stock, ranging from sheep to horses, can die after drinking the water contaminated by toxic algal blooms. Fish are usually little affected until the bloom begins to decay, either naturally or after treatment with copper sulphate, when the oxygen in the water becomes depleted. Birds seem to be generally unaffected although there are records of ducks dying following ingestion of large quantities of algae and they would also suffer from any long-term upset to the balance of the total ecosystem.

Algal blooms are usually linked with high concentrations of nutrients in the water. Although blue-green algae can manufacture their own nitrate from gaseous nitrogen in the air, they need abundant phosphate to thrive and, given a sufficiently rich nutrient cocktail, and plenty of warmth and light, certain algae can quickly form extensive blooms. Knowing these generalised requirements, however, does not allow scientists to accurately predict when blooms will or will not occur. Unravelling the various elements of any ecosystem is difficult, the more so when any additions to a stream or its catchment can manifest themselves hundreds of kilometres downstream.

The many and varied inputs into our waterways make analyzing the requirements for bloom formation particularly difficult. In a typical catchment, the leaching of pesticides might kill the aquatic grazers at the same time as fertilizer or sewage inflows enhance the algal growth. It is, perhaps, harder to understand why we don't have more algal blooms! For what its worth, modern farming practices and urban sprawl cannot be totally to blame. In 1878 Lake

Alexandrina in South Australia was covered in a green, oil-like scum caused by the blue-green alga *Nodularia* and sheep, cattle and horses died within hours of drinking the putrid water.

Yet, all is not gloom and doom, and relatively simple remedies are sometimes available. Diverting or treating sewage outflows can solve the problem in some catchments. In others, modification of agricultural practices may be required. A reduction in fertiliser or pesticide use and less intense land cultivation may reduce crop yields, but such compromises might be necessary to keep water supplies and recreational lakes open.

Killing the algae with copper sulphate or one of the other commercial products available is only a stop gap measure which inevitably affects the rest of the aquatic ecosystem. It also means that a reservoir is put out of action for at least a few days every time a bloom appears. If left alone, a bloom will either run out of nutrients or decline with the onset of cooler weather or a flush of fresh water. The decaying algae can then cause a whole new series of problems (often including a new influx of nutrients into the water) which must be dealt with before the water supply goes back into use.

Friendly algae

Perhaps to counteract this antisocial tendency, other algae absorb some of the toxic additions to our waterways. While they will hardly dilute the soup of chemicals that flows through a river, such as the lower Yarra, they can be used to assess its overall health.

In Europe, a range of aquatic plants are sampled as a indirect means of measuring heavy metals, such as iron and lead, in their rivers. Algal species similar to those growing in the Yarra River have been found to accumulate heavy metals in proportion to the concentration of the metal in the water. Grinding up the algae and measuring its metal content has many advantages over sampling the water directly. Sensitivity is increased due to the

higher levels in the alga. Algae are more easily collected and stored than water samples. A one-off pulse of pollution may be missed by sampling the water, but the algae will generally reflect the long-term quality of the water. There are additional technical benefits associated with the chemistry of the metal inside the alga and its homogeneous spread throughout the cells.

The presence or absence of certain algae can also be used to gauge the degree of pollution in a particular stretch of river. A more detailed survey of the algal community, such as measuring the proportion of various species and the total amount of algal material can provide further clues to the well-being of a river or lake. The Yan Yean Reservoir, for example, has been given a clean bill of health based on its microalgal community (Tyler and Wickham 1988).

Regular monitoring of algae occurs in only a handful of Australian rivers and lakes, but algae, in conjunction with other biological, chemical and physical measurements, are widely used in Europe and North America to help combat the decay and decline of their inland waters. Here in Australia we have the remnants of some superb river systems, some catenated with reservoirs and we need to look beneath the surface into the world of aquatic plants and animals, both for their beauty and as a means of conserving and restoring the rivers.

Algae are just one part of the intriguing underwater ecosystem. As on the land, there is a complex web of interrelationships and interdependencies. Tangled and tufty filaments provide a home as well as an occasional meal for aquatic insects. The smaller algae attached to these filaments (such as diatoms) are readily devoured by aquatic animals. The small animals are eaten by bigger animals and so we work our way up through the fish to us. There is a network of similar paths, some providing food for marine animals in the bay, and others leading to land animals that live by the river. Of course there can be a more direct route from alga to human. The blue-green *Spirulina* is relatively well-

known to 'health food' enthusiasts and, more obscurely, a local delicacy in India called 'Hair of Stones' consists of fried strands of a red alga collected and dried from local streams.

And this is only part of the story. Much to the delight of phycologists, algae are everywhere, from the snow on Donna Buang to the men's urinal in Elizabeth Street. They can cover the south side of tree trunks, smear across muddy paths and roofing tiles, or colonize areas from the merest of fissures to entire floodplains. There is no escaping them.

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Cyanobacteria: A Problem in Perspective?

by Russell J. Shiel* and John D. Green**

Introduction

Cyanobacteria or blue-green 'algae' are photosynthetic *prokaryotes*; they share more of their characteristics with bacteria than with true algae (*eukaryotes*). In particular they lack membrane-bound organelles such as nuclei and chloroplasts which are found in the true algae. They are an extremely ancient group - fossil *stromatolites*, calcareous accretions formed by cyanobacterial mats in the estuarine waters of Western Australia, are more than a billion (1×10^9) years old. Living stromatolites are still found in places like Shark Bay, providing evidence of continuous occupation of this continent by these tiny organisms - they may have been the first settlers!

Over such an extraordinary time frame the cyanobacteria have radiated to fill a diverse range of 'niches'. Some 2000 species of cyanobacteria occur in the free-floating *plankton* communities of oceans and freshwaters around the globe, in the ice of glaciers, on the surfaces of rocks in deserts, in hot springs. They are important components of aquatic food webs - some cyanobacteria have formed an unparalleled series of symbiotic relationships with other organisms, from bacteria to mammals. The red mats of *Azolla*, the floating fern of Australian billabongs, for example, harbour the cyanobacterium *Anabaena azollae* in their frond cavities. The *Anabaena* is able to fix atmospheric nitrogen, giving the fern a competitive advantage where nitrogen may be in short supply. Asian ricefield farmers have recognized the fertilizer value of *Azolla* for centuries - a value added by the cyanobacterium.

Cyanobacteria clearly are good at what they do best, getting by and making a living in marginal environments. Their

evolutionary adaptations give them an 'edge' under such conditions, including nitrogen fixation as mentioned above, the ability to assimilate more nutrients than they actually require at the time ('luxury uptake'), the ability to adjust their buoyancy by producing gas vacuoles and thereby maintain an optimal position in the water column, the ability to photosynthesize in low-light conditions, and the ability to produce spores that can survive for years in soil or sediments. Some cyanobacteria produce compounds which inhibit the growth of other algae, another competitive advantage. However these compounds may impart tastes or odours to the water. More significantly, they may be toxic to animals which drink the water, particularly when unusually large population growth occurs - a *bloom*.

The first recorded toxic bloom of cyanobacteria was in 1878, when a report in *Nature* noted stock deaths from drinking water containing a bloom of *Nodularia* in Lake Alexandrina, South Australia (Frances 1878). Subsequently, other genera of cyanobacteria were implicated in stock losses, and as the cause of skin irritations and gastrointestinal disorders in humans. Genera likely to produce toxic effects include *Anabaena*, *Aphanizomenon*, *Cylindrospermopsis*, *Microcystis*, *Nodularia*, *Nostoc* and *Oscillatoria* (Fig. 1). Three classes of toxins have been identified: **hepatotoxins** (which produce liver damage), **neurotoxins** (neuromuscular damage, respiratory failure) and **endotoxins** (gastroenteritis, allergic reactions) (Falconer 1989).

The increasing frequency of toxic cyanobacterial blooms globally has been mirrored in Australia, culminating in the 1991 Darling River bloom of *Anabaena circinalis*/*A. spiroides*, which was reported in the media as 'the world's biggest', extending for 1000 km. Another world first was for the toxicity of the 1991 Lake Mokoan *Microcystis* bloom - the most

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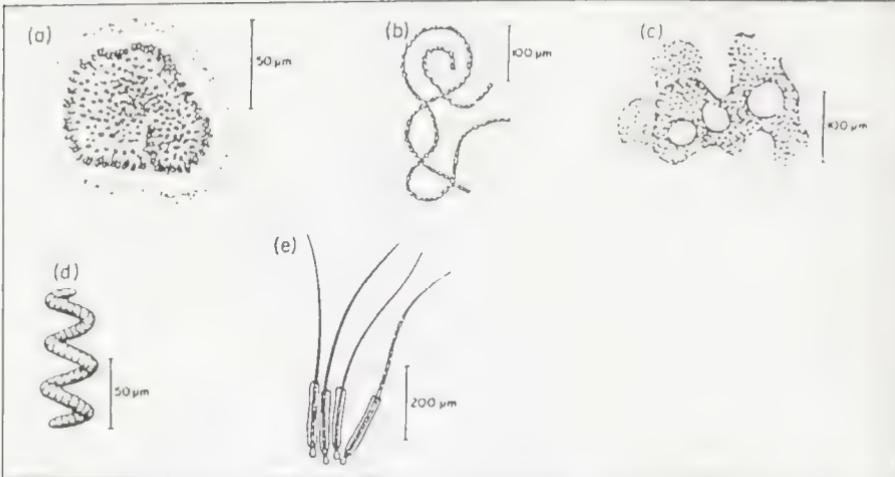


Fig. 1. Various genera of cyanobacteria (a) *Gomphosphaeria* colony; (b) *Anabaena*; (c) *Microcystis*; (d) *Spirulina*; (e) *Gloeotrichia*; (f) *Oscillatoria*. (W.D. Williams in Gutteridge, Haskins & Davey 1992).

toxic strain yet recorded. Cyanobacterial blooms have become a regular event in our inland waters; those in water supply reservoirs pose critical questions for water supply managers: what species, what strain, is it toxic, how many, how much time do we have?

Managers have tended to treat blooms as engineering problems, in isolation from the biological community of which the cyanobacteria are an integral, albeit unbalanced, part. The 'quick fix' of choice traditionally has been dosing storages with copper sulphate, an algicide, however increased dosing levels may be necessary as cyanobacterial resistance to the algicide increases. Dosing may in fact exacerbate the toxicity when toxins are released into the water from dying cells. Zooplankton and other animals also succumb to copper dosing, and at high dosing levels there may be risks to human consumers.

There is no doubt that increasing frequency of cyanobacterial blooms worldwide reflect a global deterioration of water quality, particularly by eutrophication. Eutrophic waters are those enriched by plant nutrients, especially phosphates. Australia's inland waterways have been subjected to numerous indignities over the 200 years of European

settlement, *inter alia* damming to modify flow regimes, with loss of floodplain resources (e.g. billabongs no longer accessible at appropriate times of the year for breeding aquatic animals); use as sewers for untreated or inadequately treated human and animal faecal waste; recipients of domestic, agricultural and industrial runoff, including detergents, superphosphates, pesticides, herbicides; introduction of exotic fish species; salinization resulting from inefficient agricultural and irrigation practices compounded by enormous loss of vegetation by clearing (or to fuel riverboats!) with concomitant rising water tables.

The list goes on, however my point in providing this rather lengthy introduction is to set the scene: we now have a very much modified aquatic ecosystem responding to two hundred years of conflicting demands. These demands are unlikely to diminish - we need more potable water for an increasing population, more water for irrigation, more water for waste disposal. The belated recognition of water for 'environmental needs' is a recent addition, itself likely to increase. It is critical that we understand why there are environmental needs, why biotic

Interactions and ecological diversity are relevant to water quality. Cyanobacterial blooms are a message that there are problems - for us, for our stock, for our use of limited (and endangered?) water resources. They are an indication that something is amiss in our aquatic ecosystems. To determine if they are a problem for the other inhabitants of our inland waters, we must look at the environment from their perspective.

Aquatic food webs

What each of us sees when we pass a wetland, billabong, river or lake, depends on our experience. Most of us recognize wetlands, for example, as a habitat for water birds; if we live close to a wetland or billabong we are also aware of yabbies, frogs, snakes, fish - all the larger inhabitants. What most people do not see is the remarkable diversity of smaller organisms which form the food supplies for the more visible creatures. Fig. 2 shows a very simple view of some of the interactions from the viewpoint of the grazers of algae and cyanobacteria (the compartment labelled "herbiv./bactiv. zoopl!"). Not shown are the countless species of macroinvertebrates (aquatic insects or larval stages of terrestrial insects, e.g. dragon- and damselflies) which may be integral components of such a *food web* - nor are the 'outside' organisms which may depend on the web - many species of waterbirds, such as ducks (e.g. shovellers) and spoonbills, which include microfauna in their diets.

Figure 2 is a flow diagram - the direction of the arrows indicates who does the 'eating'. For example, a microcrustacean (*Daphnia*) and a rotifer (*Keratella*) represent the approx. 1000 known species in Australia in these two groups, which, with many thousands of protozoan species, comprise the *microfauna* of our inland waters. Microcrustaceans range from approx. 0.3-4 mm in size, most rotifers are 0.2-0.3 mm. A 'normal' billabong or lake microfaunal community may contain from <20 to >100 species in this compartment

on any given day. In the figured example, they are preyed upon by carnivorous zooplankton, by the larvae and/or adults of many fish (e.g. the Murray Cod as shown). Larger fish may shift their prey to larger food items, however smaller fish such as *Gambusia*, the introduced mosquito fish, may be planktivorous as adults.

To the right of the grazers' compartment are the sources of their nutrition: bacteria, which are important in decomposition processes and recycling nutrients, and the photosynthetic true algae and cyanobacteria, which utilise solar energy to manufacture their complex compounds. 'Edible algae' are those readily eaten, mostly green algae, whereas 'non-edible algae & cyanobacteria' are those which have adaptive characteristics to preclude or minimize being eaten - e.g. long cells, filaments or clumps of cells, distasteful compounds, gelatinous sheaths. Certainly there are specialized grazers in the zooplankton community which can get around the problems of large algal filaments by boring holes in the cells and sucking out the contents, or by living inside large globular colonies of green algae and eating them cell-by-cell, or by nibbling filamentous cyanobacteria end-on, like spaghetti. Generally, however, these more difficult plankters are not preferred. The arrows from other compartments indicate that the grazers are often omnivorous rather than strictly herbivorous or bacteriovorous; either by accident or design they may include protozoans in their diet.

These other compartments of the food web are virtually a 'black box' in Australia - little is known of the species composition or ecology of Australian protozoan communities. Suffice to note here, the major feeding groups are shown: rhizopods (amoebae) may be carnivorous predators or scavengers of dead and decaying organisms; heterotrophic flagellates and nanoflagellates (those <50 μm in size) utilise bacteria or organic particles in suspension (Fenchel 1986); ciliates occupy a remarkable range of niches with diverse

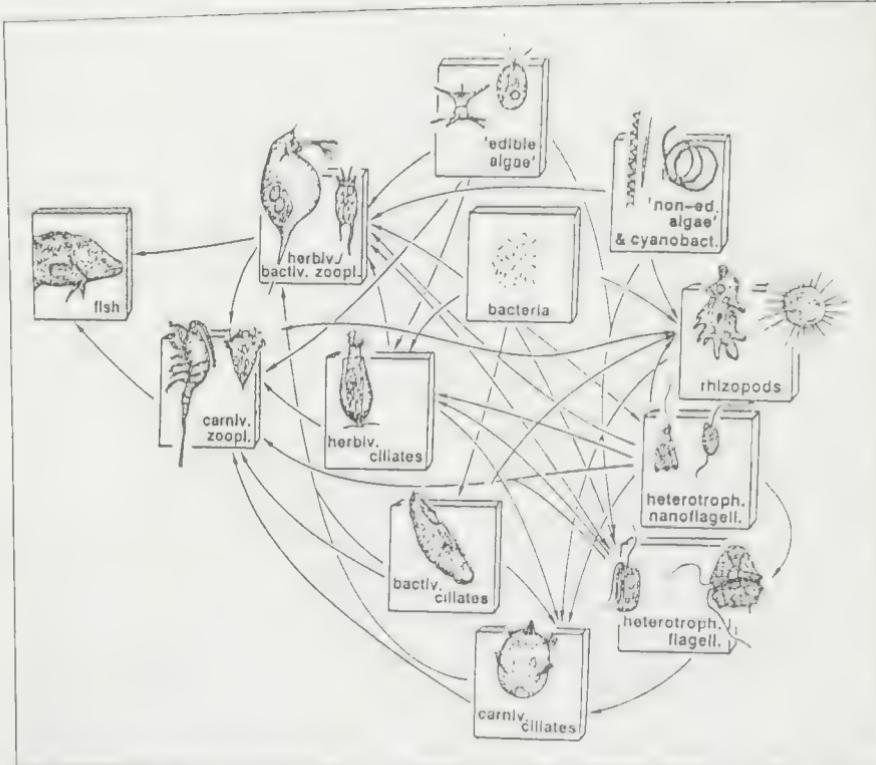


Fig. 2. Simplified microfaunal food web from Murray-Darling waters (concepts adapted from Arndt & Nixdorf 1992).

feeding specialities upon bacteria, algae, cyanobacteria and other microfauna. Some have symbiotic algae, and utilize the products of algal photosynthesis. Whatever the mode of nutrition, multiply these interactions by the many hundreds of species which occur in any one habitat at any time, add a temporal component as the species composition changes in response to natural cycles, and you will gain some idea of the biotic complexity.

Human impacts on aquatic food webs

Imbalances of cyanobacterial populations in our inland waters are an ecosystem response to human activities, i.e. interference. Can we identify the areas in the aquatic ecosystem where our activities interfere? Again, from the grazers' perspective, we can further simplify the food web and look at the factors which impinge on their 'compartment' (Fig. 3).

There are at least three points at which our activities have an impact. Firstly, phytoplankton and bacteria respond to fluxes in the nutrient pool and, in this example, are grazed by herbivorous and omnivorous zooplankton. The nutrients either cycle back to the nutrient pool as waste products or on death, or to higher levels as shown, which incorporate them in a longer, but ultimately returned, tissue store. Addition of excessive nutrients such as agricultural fertiliser or sewage at the nutrient pool provides the stimulus for phytoplankton/bacterial growth beyond the grazing capabilities of the zooplankton.

A second level of interference is at the grazing compartment itself. Agricultural chemicals, including pesticides, herbicides and petroleum wastes, can profoundly effect the microfaunal grazers. For example, pesticides in a catchment may leach into the rivers, depress or kill the

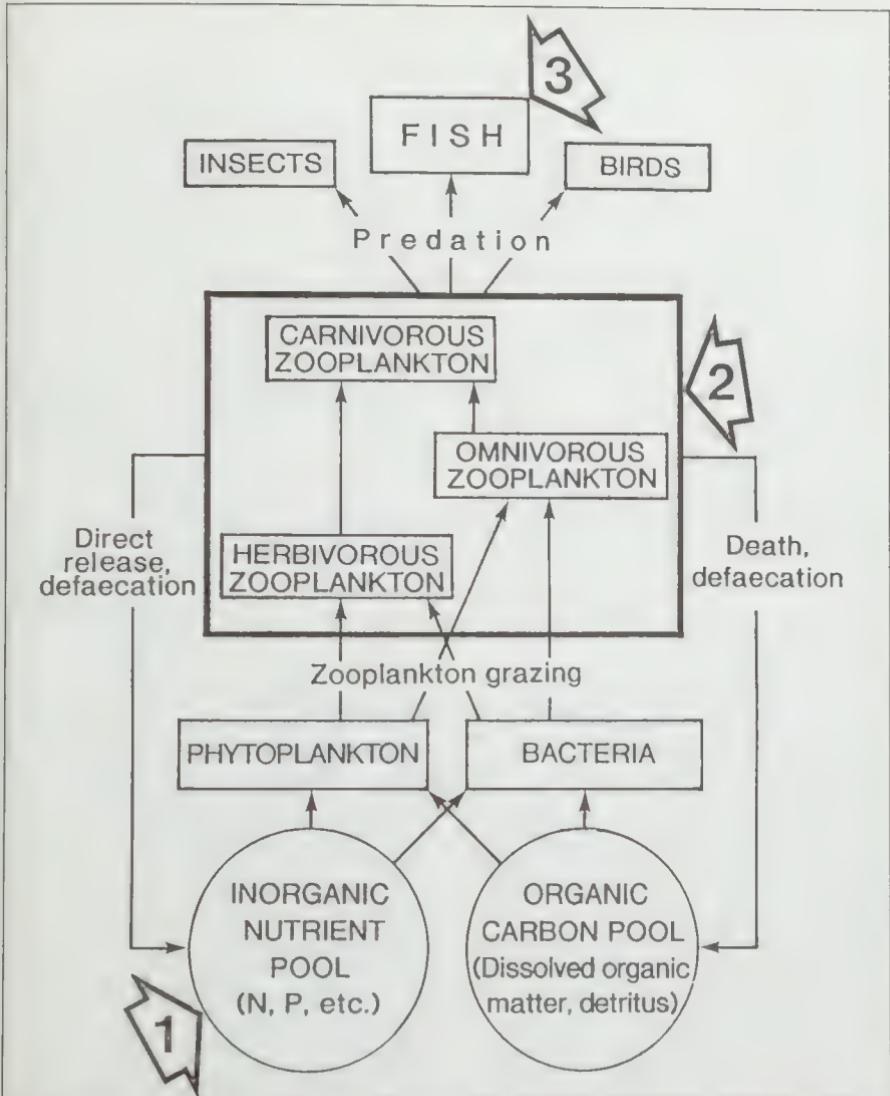


Fig. 3. Points at which human activities can have major impacts on biotic components of inland waters: 1. by adding to the nutrient pool; 2. by deleterious effects on microfaunal community; 3. by modifying the predator populations (modified after Green & Shiel 1992a).

zooplankton community with little or no effect on phytoplankton. In the characteristically turbid waters of the Murray-Darling Basin, where nitrogen may be limiting, cyanobacteria are advantaged, grazing pressure is minimal, a bloom is possible.

Human activity may also disrupt the 'balance' at the top of the flow diagram. A balanced ecosystem has predators in proportion to available prey. What is the consequence of creating an imbalance by stocking our waters with vast numbers of exotic fish, most of which are

planktivorous in their juvenile stages (redfin, trout)? Similarly, what are the consequences of accidental introductions of planktivores, e.g. *Gambusia affinis*, the mosquito fish, and more recently *Oreochromis* tilapia, on our zooplankton, littoral microfauna and macroinvertebrates? Removal of grazing pressure on phytoplankton and cyanobacteria is a likely corollary, albeit little studied in Australia.

The 1991 blue green blooms

We were members of the scientific advisory team which investigated the Darling River *Anabaena* bloom in Nov.-Dec. 1991, and our observations on the problems confronting the resident grazers are specific to it. The Lake Mokoan *Microcystis* bloom was the culmination of a different set of events, however, significant nutrient enrichment from a variety of sources is considered a common contributor to both blooms, and the problems faced by the grazers appear to be similar.

The Darling River bloom was triggered by the combination of conditions in the Darling at that time - low flows, lowering of turbidity, anoxic bottom waters, bacterial action, and resolubilization of sediment-bound phosphorus (Blue-Green Algae Task Force 1992; Gutteridge, Haskins & Davey 1992). Under these conducive conditions, very high densities of *Anabaena circinalis* and *A. spiroides* developed during October-November (in places, $> 1 \times 10^6$ cells ml $^{-1}$), akin to heavy green paint in scums on the surface. The blue-green 'alert' level issued by the State Pollution Control Commission at that time was 2,000 cells ml $^{-1}$!

Despite the very high densities of cyanobacteria present, and the presence of toxins, collections by plankton net from the bloom in late November and mid December contained a diverse assemblage of microfaunal grazers. On both occasions a mix of green algae and cyanobacteria occurred, with proportionately more green algae in the December series following flushing flows down the Darling diluting

the bloom. There was a marked difference in the community composition of the grazers on the two collecting dates. The November samples were dominated by larger microcrustaceans (the calanoid copepod *Boeckella triarticulata*, and the cladocerans *Bosmina meridionalis*, *Ceriodaphnia* sp., *Daphnia carinata* and *Moina micrura*) with smaller rotifers incidental. The December series was dominated by rotifers (20 spp.) with microcrustacea incidental. The rotifers on both occasions (predominantly species of *Brachionus*, *Filinia*, *Hexarthra* and *Keratella*, cf. Shiel 1985) are bacterivores, or grazers of small green coccoid or euglenoid algae, and will not be considered further here. The larger zooplankters are known elsewhere to eat blue-greens: Burns *et al.* (1989) and Burns and Xu (1990 a,b) have shown that *Boeckella triarticulata* has particularly high ingestion rates of cyanobacteria and is able to survive and reproduce on a diet of *Anabaena*. It was therefore of primary interest for us to determine if *Boeckella* and the other large microcrustaceans were eating the *Anabaena*. This was done by analysing the gut contents of the microcrustaceans from both sample series and by offering *Anabaena* collected during the bloom to *Boeckella triarticulata* in laboratory experiments.

Microcrustacean gut content analysis

Gut contents of major microcrustacean species were examined by placing a number of specimens from each sample in lactic acid. The preparations were left overnight to clear. Dissection methods are detailed in Green and Shiel (1992b). All HP examination was at 480X using Nomarski Interference Contrast optics (Olympus BH-2 microscope). Each microcrustacean specimen was scored for presence/absence of cyanobacteria in the mouthparts (copepods) or food groove (at the base of the trunk limbs - cladocerans), and for the presence/absence of cyanobacteria in the gut contents.

In all samples only the 'raptorial'

cyclopoid copepods ever had predominantly empty guts. Most specimens of the grazers had guts which were largely full. This was true even in samples, in which cyanobacteria were apparently 'clogging' the mouthparts or food grooves of the animals (Fig.4). This indicates that such clogging does not completely hinder feeding, although it might reduce feeding rate. Preliminary feeding observations using live cyanobacteria from Bourke Weir pool fed to *Boeckella triarticulata* adults indicated that the animals were feeding almost entirely on green algae and that the low densities of cyanobacteria prevailing in this sample series did not interfere with feeding or clog the mouthparts.

There were marked differences in cyanobacteria ingestion between species and between sites in November. At sites with very low cyanobacteria concentrations (230 cells ml⁻¹), neither *Boeckella* nor *Bosmina* had ingested cyanobacteria, but

a few *Daphnia*, *Ceriodaphnia* and *Moina* had done so. The latter taxa had cyanobacteria in their feeding appendages, whereas *Boeckella* and *Bosmina* generally did not. At moderate cyanobacteria concentrations (24,000 cells ml⁻¹) all taxa had cyanobacteria in their guts, in particular *Boeckella*, *Ceriodaphnia* and *Moina* a high proportion of individuals contained large numbers of cyanobacteria. All taxa (except *Bosmina*) had cyanobacteria in their feeding appendages. At very high cyanobacteria concentrations (256,000 cells ml⁻¹ and 144,000 cells ml⁻¹ respectively) the proportions of animals with cyanobacteria in their guts was much lower, although all species had large amounts of cyanobacteria in their feeding appendages (Fig.4). In these samples, when cyanobacteria were present, there were generally only very few cells in the guts, although guts generally were full of small particulate material and green algal cells, e.g. *Scenedesmus*.



Fig. 4. Microcrustacean zooplankton (*Boeckella* left (actual size 2.5mm), *Moina* right (actual size 1.1mm)) from the 1991 Darling River *Anabaena* bloom (Greenacres 01.XII.91) in which feeding appendages are clogged with spiral filaments of *A. circinalis*. (RJS orig.)

Conclusions

There were healthy zooplankton populations in the Darling during and after the *Anabaena* bloom. We concluded from the Darling samples that at low concentrations of cyanobacteria, cyanobacteria cells are collected but not ingested. However, at moderate concentrations, ingestion rate of cyanobacteria increases markedly, particularly by *Boeckella*, *Ceriodaphnia* and *Moina*. In very high concentrations, cyanobacteria were still collected by the feeding appendages, but were ingested at much lower rates than in moderate cyanobacteria concentrations. The cause for this decline in cyanobacteria ingestion at high concentrations is not known, but we could speculate that it may be one or both of mechanical interference with feeding-limb movements or toxicity of the cyanobacteria at high concentrations. These observations generally support what is known about ingestion of cyanobacteria by zooplankton (Haney 1987; Burns 1987). Most cladoceran species, e.g. *Ceriodaphnia*, *Daphnia*, *Moina* are known to ingest various genera of cyanobacteria, although their ingestion rates can be lowered by toxic chemicals secreted by some cyanobacteria.

It is unlikely that the microcrustacean grazers have much potential for controlling cyanobacterial blooms given the existing imbalances in our aquatic systems. While we continue to pour in nutrients the stimulus for cyanobacterial growth will continue. Calls to introduce exotic fish which eat cyanobacteria (e.g. tilapia) should be viewed with extreme concern *viz* the effects of other exotics in our rivers already. Only when we address alternatives to the continued regard for our waterways as sewers (no, it doesn't go away!) and reduce the excessive and multiple demands on the water we share with other animals, can the imbalances be redressed.

Acknowledgements

The 1991 Darling R. collections were made possible by support for the Scientific Advisory Team by the NSW State Pollution Control Commission. The team was headed by Prof. P. Cullen, Canberra University, and included Dr Green (then on sabbatical leave from Waikato at MDFRC) who completed gut content

analyses of the microcrustacean zooplankton, Drs Oliver and Shiel from MDFRC. Dr Rod Oliver is thanked for collecting the November sample series for us, and for constructive criticism of a draft manuscript.

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Hedley: Orchid Paradise?

Terri G. Allen*

Hedley, a tiny farming area astride the South Gippsland Highway between Yarram and Forster (Fig. 1), has long been known, thanks to the Rossiter family of Hedley, for its wealth of orchid species. Sheltered by the Strzeleckis and Hoddle Range and with Wilson's Promontory to the south, the region was intermittently inhabited by the Kurnai with their fire-stick regime. When Gellion took up his extensive lease between the Agnes and Albert Rivers in 1844, the area had three main vegetation zones; mangroves and salt marshes hugging Corner Inlet; tall open forests of yellow and white stringybark, messmate, peppermint, bluegum and blackwood, with pockets of rain forests in the gullies on the southern slopes of the range; and a coastal plain, a patchwork of tall open forests (manna gums, messmate, saw banksia), swamplands fringed with dense paperbark, low woodlands interspersed with grasstrees, open grassland of silver tussock and paper grass and brilliant splashes of heathland. Grazing and fire effects were the main changes then, but with the arrival of

selectors to Warrigal Corner and the Nine Mile Creek c. 1880, the district was subdivided, cleared, fenced and drained.

The Rossiters of Hedley, through observation and correspondence with orchid experts such as Tadgell, Rogers, Pescott, Nicholls, Braine and Ros Garnet, have left a wealth of detail about this orchid-rich area, Elese Rossiter tallying 120 species. Details of this correspondence are to be found in my book *Hedley: Home of the Orchids*.

Inexorably the wages of 'civilisation' ate into the floral uniqueness of the Hedley environment: clearing for dairying with its attendant use of choking pasture grasses, compaction of soil and introduction of fertilisers; weed-infested verges; encroachment by rabbits; roads and railway; draining of swamps; slashing; timber harvesting and mis-use of fire.

Government Botanist Audas visited Gellion's Run (part of today's Nooramunga Marine and Coastal Park) c. 1920:

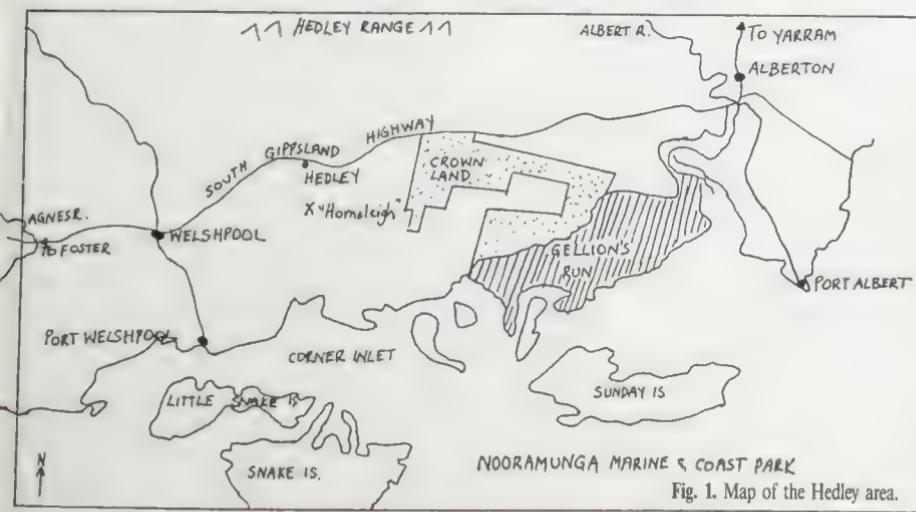


Fig. 1. Map of the Hedley area.

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'The soil was sandy, and it seemed to me that the ground over which this vegetation had spread was originally sand hummocks... a small plain was reached, where a forest of the Common Grass Tree, *Xanthorrhoea australis*, was seen in full flower, with inflorescence from eight to ten feet in height... being blackened and charred from a recent bushfire... Where the fire had burned off the undergrowth, the ground became vegetatively carpeted with orchids, which are usually sparsely found in other localities. Generally, fires have a stimulating effect on certain orchids, but here the result was more prolific than could be credited to the buried tubers, and the probable explanation appears to be that conditions have been created which are favourable to the germination of tubers dormant from former seasons. Certain species seldom bloom except after a bush fire... Growing abundantly were *Thelymitra ixioides*, *T. Longifolia*, *T. aristata*, *T. Antennifera*, *Caladenia latifolia*, *C. Patersoni*, *C. carneae*, *C. cardiochila*, *C. congesta*, *C. deformis*, *Cyrtostylis reniformis*, *Diuris longifolia*, *D. sulphurea*, *D. maculata*, *Microtis porrifolia*, *Glossodia major*, *Orthoceras strictum* and *Cryptostylis leptochila*' (Audas, 1950).

Fire, when sensibly used at the right heat and at the right season, helped colonies which relied on potash for blooming. Ruth Clark (Clark 1946) noted a great variety of unusual *Caladenias* in the Hedley paddocks after the 1926-27 bushfires; Elese Rossiter discovered a large colony of *Burnettia cuneata* (Fig. 2) in Gellion's Run and *Lyperanthus nigricans* (Fig. 3) at Welshpool. However, wildfire has ever been a problem, the 1942 bushfire razing the colony of *Sarcochilus australis* in the Hedley Range. Similarly, it has led to dense undergrowth claiming large areas of Gellion's Run. As Elese Rossiter stated: 'We had paper chases, galloped over the park-like terrain and explored. In those days (1920s-1930s) the Run was

not thick with scrub and grass trees which have only increased with excessive fires' (Allen, 1989)

In spring 1983 what is now *Caladenia fragrantissima* ssp. *orientalis* (Fig. 4) was found after an area of the Run was burnt; within two years the area was impenetrable, blanketed with thick scrub. Pescott noted the effect of agriculture upon orchids:

... into the stock paddocks... dozens and dozens of "spiders"! But what are they? *Caladenia Patersonia*? *C. reticulata*, *C. calavigera*?... But the varieties grow so close together, and show such transitory forms, that, for the present, they must be considered hybrids between the two species. We suspect the paddock has been top-dressed with superphosphate' (Pescott, 1933).

Prior to the application of fertilisers, orchids appeared to co-exist with grazing stock. In 1933 Pescott observed *Pterostylis nutans*, *Chiloglottis trapeziforme*, *Cryptostylis longifolia* in the paddocks. Elese Rossiter wrote to Audas in 1936: 'About Christmas time there was a 100 acre paddock on the plain that was white with *Pras. australis*; it was really a wonderful sight. Did you know that orchids thrive especially well in the paddocks that have been top-dressed with super (22%). I have repeatedly noticed it. The *Pt. nutans* and *falcata* grow very large and plentiful in the top-dressed area and "spider orchids", all the different kinds of them growing very large; some grow a bit crazy. And *C. menziesii*, the fields are bright with them' (Allen, 1989)

Ruth Clark noted:

'In the swamp at 'Homeleigh' (Rossiter's at Hedley)... *Cryptostylis subulata* grew thickly with fairy aprons. *Caladenia menziesii* meandered along the woolshed track, *Diuris sulphurea* and *Calochilus* grew in the hawthorn hedge of the front paddock for years and there were huge patches of *Caladenia* (spiders) and *Pterostylis falcata* in the Hedley

paddock, the latter in hundreds among the paper grass' (Clark, 1946)

Rabbits, too, had taken their toll, invading the area in the late 1920s, grazing and burrowing. This menace accompanied the gradual clearing of paddocks (an estimated 10,000 acres of sandhills, plains and swamps to hunt over, just within a few miles of home, according to Elese). Draining the swamps had led to a wide-scale depletion of orchids such as: *Pterostylis falcata*, *Cryptostylis subulata*, *Prasophyllum australe*, *Diuris pedunculata* and *Burnettia cuneata*.

Slashing, in conjunction with judicious burning, seems to be the method to maintain strong orchid growth while eliminating choking scrub. In three patches regularly slashed but free of grazing and fertilisers, the following regularly bloom: *Caleana major*, *C. minor*, *Caladenia aurantiaca*, *Cal. fragantissima* ssp. *orientalis*, *Orthoceras strictum*, *Cryptostylis subulata*, *Thelymitra ixioides*, *T. pauciflora*, *Microtis unifolia*.

The Hedley area had been noted for a number of uncommon species, but perhaps its most famous orchid is *Pterostylis alveata* (Fig. 5), a greenhood discovered by Elese Rossiter in June 1939 on Little Snake Island and which J. Ros Garnet described (Garnet, 1939):

'There were quite a number of colonies of the plant spread over the island and growing abundantly in patches of five to eight square yards, in black coastal sand among messmate and bracken fern.

...Growing in association with it were *Acianthus exsertus*, *Ac. reniformis*, *Pterostylis nutans* and *P. Pedunculata*. Other *Pterostylis* noted as growing on the island were *grandiflora*, *nana*, *alata*, *vittata* and *parviflora*'.

Elese Rossiter was asked by W.H. Nicholls for a few specimens (of *P. alveata*), one with root-system, also juvenile rosette next season - for my own work on 'The Orchids of Australia' which is in full colour. Nicholls was to recognise her collection of the following specimens in his book: *Pterostylis cucullata* 1939, *Pt obtusa* 1932, *Pt alveata* 1939, *Caladenia*

patersonii var. *arenaria* 1939 and *C. pumila*.

And what of Gellion's Run, a D.C.E. park of 1075 ha. underlain by brown coal reserves, flanked by farmland and a D.C.E. nursery? What effects have successive wildfires, agisted grazing, potato growing on swamp beds, rabbit infestation and recreational traffic had since 1920?

It was a favourite haunt of Elese Rossiter from 1913 onwards, with sixty or so orchid species found there in its hey-day. In the past twelve years only twenty three species have been located, these being widely scattered and still affected by bushfires, rabbits, road-clearing and enveloping scrub. Luckily, trial burning and slashing of patches is being undertaken by D.C.E. officers elsewhere in an effort to determine the most successful way to preserve and promote orchid growth.

Should areas of heathland/scrub/forest be burnt to re-establish seedlings? If so, when is the best time? Elese Rossiter believed a cool burn in January or in a lush year, in March, would clear unwanted undergrowth without undue damage to nestlings, seeding plants and soil. Should areas be slashed regularly? Again, she believed that this is beneficial as long as vegetation is not slashed lower than 75-100 mm, thus preventing wind scour and erosion.

May the remaining orchids in the Hedley area survive as a witness to the variety and richness of Hedley's former glory. With judicious management, this small slice of paradise may be maintained, its 'Crows' (*Orthoceras strictum*), 'Moths' (*Cryptostylis subulata*) and 'Pelicans' (*Corybas unguiculatus*) (Fig. 6) and 'Gold-tips' (*Caladenia aurantiaca*) (Fig. 7) live on.

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Fig. 2 *Burnetia cuneata*



Fig. 4 *Caladenia fragrantissima* ssp. *orientalis*



Fig. 3 *Lyperanthus nigricans*



Fig. 5 *Pterostylis alveata*



Fig. 6 *Corybas unguiculatus*



Fig. 7 *Caladenia aurantiaca*

Excursion Report: Linear Parks and Urban Forests

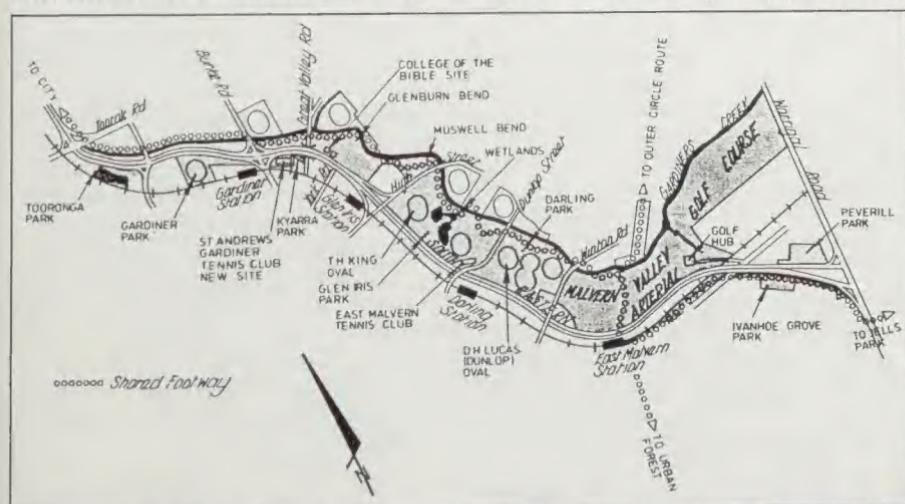
In early December, 1991, Dan McInnes led an FNCV excursion along Malvern's linear parks and urban forest area. The tour focussed on Gardiners Creek along the southeastern freeway between the Glen Iris and Hughesdale railway stations (see map).

A feature of the excursion was the southern loop of the Glen Iris Environmental Trail (see map). This trail incorporates a wetland conservation area which is part of an indigenous planting scheme for the Malvern Valley and was planted in Spring 1989. The four bodies of water, including a weir on Hedgley Dene Drain, which comprise the wetlands, were filled with water pumped from Gardiner's Creek.

A wide diversity of bird life has been seen on these wetlands including Black Duck, Chestnut Teal, Wood Duck, White-faced Heron, White-necked Heron, Rufous Night heron, Little Grebe, Straw-necked Ibis, White Egret and Australian Coot. The birds that can be seen at any one time varies according to the hour of the day, the season of the year and the conditions experienced throughout Australia. Nesting boxes, provided by the Field and Game Association, were established early in 1990.

One of these has already produced a clutch of Chestnut Teal.

Features to be seen along the trail included the aquatic and terrestrial plantings around the wetlands, the Estella Street footbridge with views of Gardners Creek, the water bodies and channels linking the wetlands, a boardwalk and Hedgley Dene Drain with its remnant indigenous vegetation at the mouth, Lake Camberwell, planting on the arterial road embankment, the planting and noise attenuation hillock near the entrance to Allenby Avenue Underpass and the indigenous plantings throughout the trail. The following indigenous plants are those most frequently used in these linear parks and our group saw most of these successfully growing in various situations in the park: Lemon-scented Gum (*Eucalyptus citriodora*), Tasmanian Blue Gum (*E.globulus*), River Red Gum (*E. camaldulensis*), Swamp Gum (*E. ovata*), Manna Gum (*E. viminalis*), Yellow Box (*E. melliodora*), Spotted Gum (*E. maculata*); Blackwood (*Acacia melanoxylon*), Lightwood (*A. implexa*), Silver Wattle (*A. dealbata*), Black Wattle (*A. mearnsii*), Golden Wattle (*A. pycnantha*),



Map of Gardiner's Creek linear reserves, kindly provided by James Gillespie.

Cootamundra Wattle (*A. baileyana*) and Hop Goodenia (*Goodenia ovata*), Sticky Boobialla (*Myoporum viscosum*), Sweet Bursaria (*Bursaria spinosa*) and Swamp Paperbark (*Melaleuca ericifolia*).

The excursion returned to Hughesdale station through an urban forest which was originally part of the Outer Circle Railway Line. The walk emphasised for us the importance of urban forests and linear parks for recreation in Melbourne.

Urban forests. This is a new approach to the development of recreational space for residents. It attempts to recreate an ecosystem which existed before European settlement and urbanisation. Featuring extensive tree planting, Malvern's urban forest includes grassy green picnic areas, ponds and wetland, pedestrian and cycle paths, bridges and slopes. This is all part of a linear park network on the old Outer Circle railway reserve between Dandenong and Waverley Road (Mel 69 B2). This old railway line joined the cities of Caulfield, Camberwell and Kew.

Linear parks. These are areas, often called green belts, set aside for recreational purposes ranging from sport, walking, cycling, running or nature study. These parks tend to be linear corridors between residential areas. In some cases they follow creek and river valleys or, as in Melbourne, disused railway lines.

There has been a strong community interest in linear parks recently as evidenced by the development of the old Outer Circle Railway route as well as the Melbourne bicycle paths along the Yarra and Maribyrnong Rivers and various urban creeks, and the former link railway between Fitzroy and Royal Park. The Outer Circle route will link various linear open spaces on Melbourne's rivers and creeks and also provides 14 km of pedestrian and cycle paths from the Yarra River at Studley Park to Back Creek in Camberwell and Gardners and Scotchmans Creeks in East Melbourne.

The history of the Outer Circle Railway

Dan McInnes gave a brief history of the

Outer Circle Railway while everyone was eating lunch in the Glen Iris Trail Grandstand.

The Outer Circle Railway was opened in 1891 and was originally built to connect Melbourne with the Government built Gippsland railway line (constructed 1870-1875) which ran between Oakleigh and Sale. Since most of the inner suburban railways were constructed and owned by a private company - The Melbourne and Hobson's Bay United Railway Company - the government had no direct line access to Melbourne from Oakleigh. Thus, they had several options, one of which was to build an outer circle line from Oakleigh through Camberwell to Alphington and Clifton Hill, Royal Park and around to Spencer Street Station. This route meant that the Gippsland goods train would avoid the city and the line would then open up all the land to the east and south-east of Melbourne. This option was favoured by politicians and developers, the latter because they had acquired vast blocks of land in this area. However, by 1878 the government had purchased 'The Melbourne and Hobson's Bay United Railway Company' for 1,320,820, and had access to the direct route from Oakleigh to Flinders Street Station, so for the first time passengers and goods could travel from Sale to Melbourne and not change to horse-drawn vehicles at Oakleigh for the remainder of the trip.

However, there was still pressure to open the outer circle line and in 1884 a Railway Construction Bill allocated 110 of the 1170 miles to the Outer Circle Line. In 1887 construction began with Sir John Monash as the engineer in charge, and was opened in 1891. Travellers then had a choice of three routes from Oakleigh to Melbourne: via Caulfield (33 minutes); via Waverley Road, Darling and Burnley (35 minutes); via Waverley Road and Camberwell (39 minutes). Unfortunately in 1893 the depression made the line uneconomic and in 1897 the line closed after only 6 years in operation.

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